AUGUST 1939

Science Library

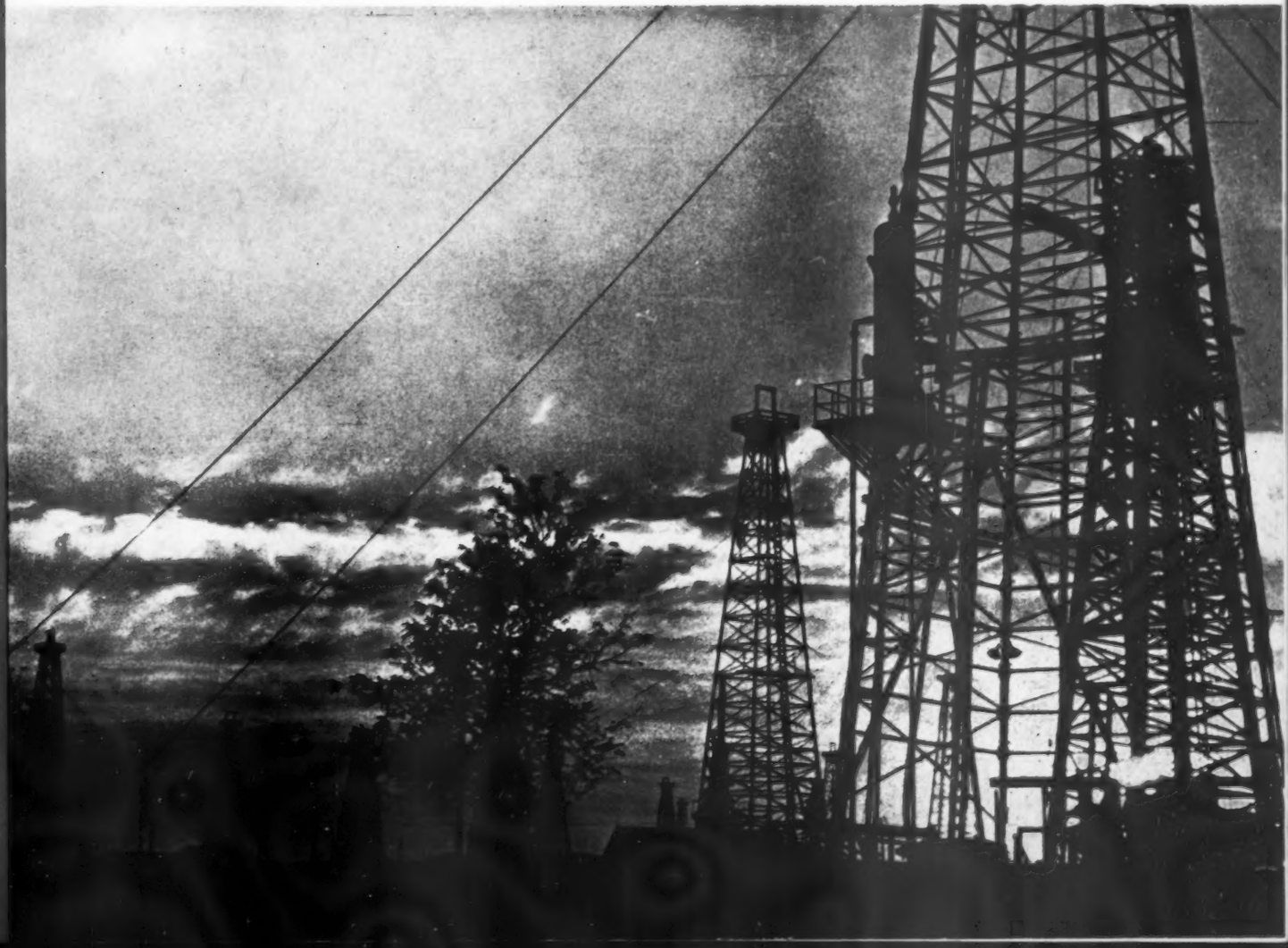
34

WORLD PETROLEUM

NEW YORK AND LONDON

NEW IRAQ PIPELINE • ILLINOIS BASIN'S COMPETITIVE POSITION

British Combine



Hanlon-Buchanan, Inc

PIONEER NATURAL GASOLINE MANUFACTURER

EXPORT TERMINALS:
Goodhope, La.
Houston, Tex.
Baytown, Tex.
Corpus Christi, Tex.

TULSA, OKLAHOMA
NATIONAL BANK OF TULSA BUILDING
PHONE 4-1101 or L. D. 358 WIRE — OR WRITE P. O. BOX 1539
Cable Address . . . STAVOLENE, Tulsa, U. S. A.

FOREIGN REPRESENTATIVE:
Barks, Williams & Co., Ltd.
4 Lloyd's Ave.
London, England

WORLD PETROLEUM

RUSSELL PALMER
Publisher

E. W. Mayo
Editor

T. Orchard Lisle
Executive Editor

E. W. Mayo, Jr.
Managing Editor

S. J. Gallay
Advertising Manager

VOLUME 10 **AUGUST . 1939** **NUMBER 8**

WORLD PETROLEUM: Incorporating Petroleum Equipment Exporter

CONTENTS

New Move for Federal Control	**29**
High Production Indicated for Illinois	**30**
I. P. C. to Double Mediterranean Line	**38**
Excess Runs May Check U. S. Earnings	**39**
Foreign Oil Legion	**43**
New Iranian Oil Concession	**44**
Increased Turnover by U. K. Companies	**46**
Continuous Regenerative H_2S Removal	**48**
World Oil Production	**52**
Abstracts of World Oil Literature	**54**
Russian Oil Survey—Emba	**62**

CORRESPONDENCE

ADDRESS all correspondence regarding subscription and business matters to the Home Office; 95 River Street, Hoboken, N. J.

Editorial and Advertising offices; 56 West 45th Street, New York, N. Y. London office; 3 Savoy Place, Victoria Embankment, W.C.2.
Los Angeles office; 412 West 6th Street

SUBSCRIPTIONS

ANNUAL subscription to WORLD PETROLEUM is offered at the flat rate of five dollars (U. S.) postpaid to any country in the International Postal Union.

For the convenience of subscribers the publisher will accept payment in any of the following currencies at the fixed rate shown below:

Argentina	16 paper dollars
Canada	5.00 dollars
Colombia	5.55 pesos
France	190 francs
Germany	13 reichsmark
Great Britain	1 guinea
Netherlands	10 guilders
India	15 rupee
Iran	1 guinea
Iraq	1 guinea
Italy	95 lire
Japan	20 yen
Mexico	25 pesos
Peru	25 sol
Poland	27 zloty
Roumania	675 leu
Russia	6 roubles
Venezuela	17 bolivar

Remittances or drafts should be drawn to the order of the Publisher, WORLD PETROLEUM, payable in New York and London.

Subscriber's name and address should be in Roman capitals on the subscription order.

Official position of subscriber is requested.

Advance notice, if possible, of a change of subscriber's address should be given.

AGENCIES

SINGLE copies of WORLD PETROLEUM are obtainable every month, within the delay imposed by the international mail service, at any of the following agencies:

CARIMAS, VENEZUELA—The German Store.
BERLIN, 35, W. GERMANY—Verlag Chemie G.m.b. H. Corneliusstrasse 3.
MARACAIBO, VENEZUELA—High Life Tailors.
THE HAGUE, NETHERLANDS—Martinus Nijhoff, Lange Voorhout 9
LONDON—World Petroleum, 3 Savoy Pl., Victoria Embankment, W.C.2, telephone: TEMple Bar 1735
A. C. Hardy, 110 Penchurch St. E. C. 3
W. H. Smith & Sons, Ltd., Moorgate Met. Station
Willing & Co., Ltd., Moorgate Met. Station
Barker & Howard, 6 Fenchurch Buildings, E. C. 3
NEW YORK—Telephone Hoboken 3-2480 for list of 20 newsstands carrying copies
PARIS—Librarie Brentano, 37 Avenue de l'Opera.
PORT OF SPAIN, TRINIDAD—Davidson & Todd, Ltd., 8 Frederick St.
LOS ANGELES—412 West 6th St., telephone: Mutual 1391.

The price of monthly copies is 2 shillings in countries of the British Commonwealth and the equivalent of 50 cents (U. S.) elsewhere.

PARTICULAR NOTICES

MANUSCRIPTS and photographs submitted to the editor are received only at the owner's risk. Prompt consideration will be given to them.

The Publisher does not necessarily endorse the views expressed by authors of signed articles. In the service of readers he will not hesitate to give publication to signed opinions in direct opposition to his own.

Advertising rates obtainable on request.

COPYRIGHT

COPYRIGHT, 1939, by Russell Palmer. Contents may not be reproduced without permission.

EDITORIAL

ILLINOIS—TODAY AND TOMORROW

NO OTHER oilfields in the United States have attracted more attention and discussion during the past two years than have those of Illinois. This has been due not merely to their prolific yields although their present output, approaching 300,000 bbl. daily, is much above the anticipations held at the time when the first wells in the new areas were brought in. Even more important considerations have been their geographical situation and the fact that the only curb on output for a large part of the district has been the ability to find purchasers, a condition that has led to extensive price cutting.

Illinois production has had an influence marketwise out of proportion to its actual volume mainly because of its location. Situated close to the great consuming areas of the north central states, and lying athwart the routes by which Mid-Continent oil travels to reach Chicago, Toledo and other refining centres, Illinois producers have enjoyed the advantage of low transportation costs to reach these important markets.

As a result of this advantageous situation, combined with a willingness on the part of some producers to cut prices, Illinois oil has displaced a considerable volume formerly drawn from Kansas, Oklahoma and New Mexico. In a market rather too well supplied this naturally has brought protests from producers in the latter areas. They of course cannot gainsay the geographical advantage held by Illinois but they do complain that Illinois wells are produced wide open and are subject to none of the limitations imposed by the conservation laws of the Mid-Continent states.

The development of the Illinois fields and their relation to pipeline systems and refineries in the territory between the Great Lakes, the Ohio and the Mississippi rivers are fully set forth on other pages of this issue. The conclusions drawn in this discussion are that Illinois production will be maintained at a high rate in the immediate future and that it will occupy a preferred position in that important area so long as this condition continues.

Robert Yarnall Ritchie

Shadow or Substance

THIS really is the crux of the matter; how long will the fields of Illinois be able to pour forth their hidden riches at the lavish rate now in effect? The answer is written in the history of scores of other fields produced in the same reckless manner from the days of the first oil rush along Oil Creek in Pennsylvania down to the present time. Pithole, Spindletop, Cushing, and dozens of others tell the same story. A lucky strike, a swift rise to glory, frantic drilling, dissipation of pressures and than a quick decline to relative obscurity or total abandonment. The ghosts of once flourishing but now forgotten towns scattered across the continent are monuments to the recklessness and cupidity of those whose overeagerness destroyed the substance and left only the shadow of which might have been an enduring prosperity.

Thirty years ago Illinois was one of the three principal oil producing states of the Union though its production then came from fields others than those that are being exploited today. There was similar activity and excitement, feverish haste in drilling and a rush to provide facilities for handling and transporting crude. There was the same disregard of care and system in the effort to skim the cream from the fields in the shortest possible time. Within two years after the peak of production was reached output began a decline that was continuous thereafter. Since that time producers in these earlier fields have been laboriously pumping a modicum of the oil that might have been obtained through saner methods. History repeats itself but the memories of men are not long enough to bridge the gaps.

It is significant that while much apprehension was expressed in the oil trade during 1938 as to possible disorganization of the market and a break in the crude price structure as a result of unbridled production in Illinois, the subject is one of less concern at the present time although the daily output of the fields is still rising. The explanation lies in the realization

by oil men of knowledge and experience that with a continuation of present methods production in Illinois will reach its peak within a relatively short time and then will enter upon a steady and probably a rapid decline. Many men of long experience in the oil industry believe that the high point in Illinois production will be reached shortly after daily output passes the mark of 300,000 bbl.

Why Conservation Lags

EFFORTS have been made in Illinois to enact laws similar to those now in effect in a number of states for the prevention of waste and prolongation of the life of the fields. These efforts have met with no success thus far and from present indications there is small likelihood of effective action before a sharp decline in output signalizes the serious impairments of potentials. The politicians are openly against an effective conservation law or lukewarm in their attitude toward it. Landowners who have not yet tasted the sweets of royalty payments that their neighbors are enjoying are opposed to any curtailment. Drillers who have put down wells on borrowed capital or by the near exhaustion of meagre resources are anxious to pay out as soon as possible. The general public is not sufficiently informed to appreciate the certain effects of ruthless exploitation and so to rally a strong body of opinion in support of the conservation movement. In the fields which are mainly controlled by financially strong companies proper spacing of wells and production at a rate calculated to maintain bottom pressures are being practiced voluntarily. Elsewhere there is no such restraint. In one of the most prolific fields in the state, wells are being put down so closely and rapidly that it is probable that a great part of the potential production will be lost.

In the early days of the oil industry, many potentially great fields were ruined through lack of knowledge of sound methods of production. Since that time, experience has demonstrated that too close spacing of wells and too rapid production is very likely to shorten the life of fields and to reduce greatly the recovery per acre. In the long run everybody concerned loses by such practices—the producers themselves, the royalty owners, the state and all its citizens.

So well has this lesson been learned in the states that have been large producers of petroleum over an extended period that some system of control, either through state laws or by voluntary action, is solidly established. It is recognized that regulation of production in accordance with well established practices for the preservation of bottom hole pressures and avoidance of waste extends the life of any field to which it is applied and so increases the ultimate return to everyone who participates in its yields. The demogogic claim that it is a device of the larger companies to promote monopoly is disproved by the fact that the so-called independent or small producers who are numerically a large majority in the industry are for the most part staunch supporters of regulation in the states where it is in effect.

The strongest argument for regulation, state or voluntary, in Illinois or elsewhere, is the argument of self-interest. Nobody can predict accurately in advance just what figure will represent the peak of production in Illinois or just when the peak will be reached. There is plenty of oil history to indicate that if sound principles of conservation are disregarded, the decline in production, once that point is passed, will be rapid and severe.

Records compiled by the American Petroleum Institute of a large number of fields produced without restraint or regulation show that within a year after reaching their peaks, output dropped more than 50 percent. Within two years, it had fallen nearly 80 percent.

More Haste Less Gained

IT IS A matter of simple arithmetic to figure that if a group of fields yielding, let us say, 500,000 bbl. daily, drops to 100,000 bbl. in the course of three years, the producers of that area and all who are dependent on it are much worse off than they would be under a system of proration which held their output to 250,000 bbl. over a decade or more. Yet ample evidence may be adduced to prove that this is not an overdrawn illustration.

No system of proration yet devised can lay claim to absolute perfection. But long experience and careful study of the essential factors governing the recovery of oil from its natural reservoirs has shown that a system can be set up which will be broadly equitable, that it unquestionably will prolong greatly the life of the fields to which it is applied and that it will make possible the recovery of a far greater proportion of the total oil available.

The claim that petroleum producers, dealing with a commodity of immense national importance, owe an obligation to avoid its waste so far as possible may not appeal to the individual operator intent only on his personal problems. The prospect that if some states fail to adopt clearly established measures to protect their own interests and those of their citizens, the federal government will step in and take over the task may not move those in political control of state administrations. The pocketbook argument, however, is one that even the most obtuse and self-centered can readily understand and they need only refer to scores of examples from past experience to realize that members of the oil industry who oppose practical measures of conservation are robbing themselves as well as their state and the nation.

NEW MOVE for Federal Regulation Put Forward in Washington

Bill Submitted to Congress by President Would Empower Commissioner to Investigate and Prevent Waste—Announced Purpose to Coordinate Conservation Activities of State and Federal Authorities.

BASED on the recommendations of the Energy Resources unit of the National Resources Board submitted to congress by President Roosevelt last February, Representative Cole of Maryland shortly before Congress adjourned introduced a bill providing for federal regulation of the production of oil and gas and their transportation in interstate commerce.

Labelled a conservation measure and intended to prevent avoidable waste, the bill will serve as a background for study to be made by a subcommittee of the House Interstate Commerce committee with a view to suggesting legislation at the next session of Congress.

In presenting the bill, which was sent to Chairman Lea of the Interstate Commerce Committee under cover of a letter from the President, Mr. Cole said:

"It was not prepared by me or any member of the subcommittee over which I presided as chairman in 1934 during the investigation of the petroleum industry and which has handled all legislation on the subject of petroleum referred to the Interstate Commerce Committee since that time.

"The bill intends to develop fullest possible cooperation between state and federal officials and the oil industry in the prevention of waste. It is designed solely as an oil and gas conservation measure and does not attempt to control supply through the establishment of production, marketing, or transportation quotas; does not affect imports or exports of petroleum; and does not provide for any coordinated industrial action in refining and marketing."

After setting forth an elaborate series of findings on the part of Congress to the effect that wasteful production jeopardizes the maintenance of reserves and the national defense, burdens interstate commerce and constitutes unfair competition, the bill makes a declaration of policy as follows:

"It is hereby declared to be the policy of congress, through the exercise in this act of its powers to provide for the maintenance of an adequate national defense and to regulate interstate commerce, to further the conservation of petroleum by the elimination of wasteful methods and practices insofar as such methods and practices may be avoidable, and to encourage and assist the various states in their efforts to prevent the waste of petroleum."

The bill establishes an office of Petroleum Conservation in the department of the Interior to be under the direction of a Commissioner, appointed by the President and two associate commissioners to be appointed by the Secretary of the Interior. Pertinent oil activities of the federal government will be consolidated in the office of Petroleum Conservation and the Connally Hot Oil act, recently extended by Congress for a period of three years, is made permanent and its administration and enforcement placed in the office of the new commissioner.

There also would be established a Council on Petroleum Conservation consisting of 18 members, to be appointed by the Secretary of the Interior. Nine of the members would be state officials engaged in the administration of petroleum conservation laws, six would be persons engaged in the production of petroleum and three would be engaged in the teaching of subjects related to petroleum at educational institutions. The council would meet annually and at such meetings would confer with representatives of the federal government on matters that would be laid before the meeting concerning the prevention of waste in production and the civilian and military needs of the nation. The council also would arrange for a current interchange of information with the office of Petroleum Conservation on production methods and practices.

The commissioner of petroleum conservation is authorized to investigate and determine if oil or gas is produced wastefully in any field in the United States. In making his determination the commissioner shall consider; (1) the porosity, permeability and other characteristics of the deposits; (2) the nature and character of reservoir energy; (3) well spacing, drilling practices, well casing and well completions; (4) the rate of decline in reservoir pressure per unit of crude oil producted; (5) the ratio of natural gas production to the amount of crude oil produced; (6) the rate and manner of water encroachment within the productive formations; (7) the ratio of production of crude oil to estimated reserves; (8) the methods of well completion, presence of gas-caps and presence of gas-bearing zones open to any well; (9) conditions of storage of crude oil recovered; and (10) other characteristics and conditions of the source of supply and production therefrom.

If the investigation develops that waste does not occur, notice to that effect will be given to state officials, operating companies and the public. If waste is found to occur in accordance with the standards established in the bill, findings to that effect will be made and regulations issued to provide for the elimination of such waste. In the promulgation of these regulations the commissioner will be required to make provision concerning the following factors of waste: the spacing, location, drilling, completion, or production of any well or wells so as to cause waste of reservoir energy; the loss by escape or wasteful burning of natural gas; the loss, evaporation or wasteful burning of crude oil; the existence or creation of fire hazards; the drowning with water of any stratum capable of producing crude oil or natural gas, or both; the escape of crude oil from a productive formation through drainage or seepage; the premature release of natural gas from solution in crude oil; the operation of any well producing crude oil with inefficient gas-oil ratio; the inefficient, excessive, or improper use of reservoir energy; the excessive production of natural gas alone or in conjunction with crude oil from a source of supply containing both, even though such natural gas is used or transported for use in the generation of light, heat, or power; the abandonment of any well in such manner as to render any crude oil unrecoverable or reservoir energy unavailable.

Further the commissioner will be required to regard as prima facie evidence of avoidable waste any operation substantially at open-flow capacity or production "in any field at a rate which, in its relationship to known crude oil reserves, is substantially in excess of the rate of production in relationship to reserves in other fields" in which the commissioner has found waste on the basis of the enumerated factors defining waste.

State officials and operating companies would be notified of the findings and the regulations and opportunity would be given to make the corrections. If the corrective measures are not applied the commissioner is authorized to bring action in the United States district court to enjoin such practices.

The bill also provides the commissioner with authority to approve voluntary agreements to eliminate avoidable waste among the operators in any single oilfield. Likewise he is further authorized and empowered to cooperate with the officials or agencies of the states or agencies acting pursuant to agreements between two or more states and with educational and research organizations, public or private.

High Rate of Production Indicated for ILLINOIS FIELDS*

By Alfred H. Bell, Geologist and Head of Oil and Gas Division and Walter H. Voskuil, Mineral Economist

Illinois State Geological Survey

DISCOVERY and rapid development of new oilfields in southern Illinois in 1937 and 1938 has served to focus the attention of the United States petroleum industry upon the productive possibilities of that state, in its effect upon the national oil market. The effect of these discoveries upon the local oil industry in Illinois was indeed spectacular. Output of petroleum in the state rose from a settled production of 4,500,000 bbl. in the oilfields in 1936 to a level of 24,000,000 bbl. in 1938 from both new and old fields, while oil is currently being produced at a rate of 75,000,000 bbl. annually. Taken by itself this appears to be a development of unusual significance and of critical importance to oil producing districts elsewhere. Viewed as part of the national oil picture, the developments appear to be less significant, and the critical effect upon competing oil producing districts is restricted mainly to two states—Oklahoma and Kansas.

Petroleum Production in Illinois and the United States, 1936-1938, and Jan.-April, 1939*

Year	Illinois (Thousands of barrels)	United States	Percent Illinois of total
1936	4,475	1,029,687	0.41
1937	7,426	1,277,653	0.58
1938	23,929	1,212,530	1.97
1939 (To Apr. 30)	19,539	404,895	4.82

*Monthly petroleum statements, U. S. Bureau of Mines

In terms of average daily production, there has been a rise in output from 12,000 bbl. daily in 1936 (last year in which production came solely from old fields) to a reported daily production of 214,700 bbl. The larger portion of the oil so produced is marketed among refineries of the central refining district, mainly in competition with crude petroleum from Oklahoma, Kansas, and New Mexico. The place that the Illinois petroleum industry will occupy, ultimately, in the crude oil market of the central refining district depends upon the rate of discovery, extent of reserves, the rate and efficiency of production, and the ability to dispose of the crude oil output in a highly competitive market. This survey of the Illinois oil industry is limited to a review of events leading up to the recent activity, a discussion of the geology of the fields, the proved extent of reserves, possibilities of further discoveries, and the problems of marketing the crude oil.

HISTORY

Illinois first became an important oil producing state in 1904 and succeeding years with the discovery and development of the southeastern Illinois field, one of the nation's major oilfields. Illinois ranked third in the United States in oil production during 1908, 1909 and 1910. The peak of annual production was reached in 1908, and after 1910 the annual production declined practically without interruption until 1937 when it rose sharply as a result of the discovery of new fields in the Illinois basin. Present indications are that the state's production in 1939 will be approximately double that of the peak year of 1908.

The question may be asked "Why has the oil industry of Illinois been subject to such violent fluctuations in contrast to the comparatively steady state of the industry in such states as Kansas or Oklahoma?"

Beginning about 1910 there was a notable migration of oil men and oil capital from Illinois and the eastern fields to large flush fields in the Mid-Continent area. Over much of the Mid-Continent area, bedrock structure could be determined readily by detailed studies of the surface geology, whereas in most of Illinois the surface covering of glacial drift prevents the determination of structure by this method. Moreover, the southern part of Illinois was known to be a major structural basin and according to current theories of the migration and accumulation of oil, the basin was considered unfavorable territory. Although several small oil and gas pools were discovered in western and southwestern Illinois, from 1908 through 1928, they were not productive enough to reverse the steady decline of the state's production.

The discovery in 1928 of the Mt. Pleasant field in the central part of the Michigan basin, a large structural feature somewhat similar to the Illinois basin, necessitated a change in the widely held theory regarding the oil possibilities of basins. In 1930 the Illinois State Geological Survey prepared and exhibited a map classifying the state into areas of four grades with respect to oil prospects, namely: best possibilities, moderately favorable, slight possibilities, and negligible possibilities. The deeper part of the basin was included in the most favorable area. This map was based on geologic data accumulated by the Survey over a long period of years. It has been substantiated by recent developments, as 33 of the new fields discovered since January 1st, 1937, are located in the area designated in 1930 as having best possibilities.

USE OF GEOPHYSICS

When the oil companies became convinced that the Illinois basin was prospective oil territory the next problem was the discovery and delineation of favorable structures. Since the use of surface geology for this purpose appeared to be extremely limited, two companies—Pure Oil and Adams-Louisiana—decided at about the same time to try the reflection seismograph method. This method met with conspicuous initial success as the first three wells located by it discovered new pools. The Adams-Louisiana, Merryman No. 1 well came in first, January 27th, 1937,—the discovery well of the Patoka pool—on the western margin of the basin. Here the credit must be divided between geophysics and geology because a structural high on Coal No. 6 had been mapped by R. S. Blatchley.[1]

Pure Oil Company's Weiler No. 1 well, discovery well of the Clay City pool, was completed February 26th, 1937, and was the first to demonstrate that oil in commercial quantities existed in the basin. This was closely followed by the Bradley No. 1 well, completed March 4th, 1937, which discovered the Cisne pool. The location of these wells was made entirely by the reflection seismograph method, and its early success led to its large scale use by many companies during the succeeding years.

GEOLOGY

The producing sands in the Clay City and Cisne pools mentioned were the Cypress and Aux Vases formations respectively. The initial productions were comparatively small (40 and 100 bbl.). The first big well in the basin was Pure Oil Company's B. Travis No. 1, located half a mile north of the Weiler No. 1. It was completed May 15th, 1937, with an initial production of 2,640 bbl. from the McClosky sand, a porous, oölitic limestone in the Ste. Genevieve formation of the Lower Mississippian series. Since that time the principal production in the central part of the basin has been from the McClosky.

In the latter part of 1937, the Louden (Beecher City) field, Fayette County, and in July, 1938, the Salem (Lake Centralia) field were discovered on the western side of the basin. These two fields now produce about three-fourths of the state's oil, Salem alone yielding more than half the total. The Salem field is now reported to rank second in the United States in daily output, being exceeded only by the East Texas field.

The principal production in both the Louden and Salem fields is from sandstones in the lower part of the Chester (Upper Mississippian) series. In the Louden field both

Published with permission of the Chief, State Geological Survey, Urbana, Illinois

[1] Blatchley, R. S., Oil resources of Illinois: Illinois Geol. Sur. Bull. 16, Plate 14, 1910.

Globe

An independent discovered that major companies had leased all good prospects in Washington County, Illinois, but overlooked Oak Grove cemetery. He leased the site without undue furore and (above) moved in a drilling rig a week later. Scouts from other oil companies watched closely. Oil was struck (right) in the Benoist sand at a depth of 1,267 ft. — a free-flowing test.

the Cypress and Benoist or Bethel formations are productive, as well as the stray sand in the Paint Creek formation. In Salem, the Cypress sandstone is water-bearing, and oil is produced from the Benoist, Aux Vases, and McClosky. Some wells recently drilled on top of the structure, producing from the McClosky, have had estimated initial flow (based on a three-hour test) as high as 4,800 bbl.

The accumulation of oil in the new Illinois fields seems to be controlled mainly by large closed structures. The development of several of the newer fields has not gone far enough to reveal the structural conditions in detail, nor the extent of the producing territory. Recent development has been so rapid that there has been no opportunity for the estimation of reserves based on detailed studies. It seems conservative to say that the recoverable reserves in the known fields of the state are of the order of 400,000,000 bbl. There still remains much untested territory and with the large amount of wildcat drilling now in progress it is probable that many new fields will be discovered.

MARKET OUTLET

The normal outlet for petroleum produced in Illinois is among the refineries of the central refining district.[2] Some Illinois petroleum moves eastward beyond the boundaries of the central refining district into the Appalachian

[2]The central refining district, as here defined, includes refineries in Illinois, Indiana, Michigan, Kentucky, and western Ohio. It corresponds to the Bureau of Mines' designation of the Illinois-Indiana-Kentucky, etc., district.

Immediately after the Oak Grove Cemetery discovery, the majors drilled offset wells to protect their own leases — one almost touching the discovery hole.

district and small quantities are also shipped into Canada. The location of the central refining district among other areas in the United States and the distribution of refineries within the central district are shown in accompanying illustrations.

The refineries located within the central refining district range from small plants of 2,000 to 3,000 bbl. daily capacity to large refineries of 10,000 to 40,000 bbl., and one plant with 100,000 bbl. daily capacity. Some of the small refineries have pipeline connections with producing fields in the Mid-Continent area.

Practically all of the larger refineries are equipped with cracking plants for increasing the recovery of gasoline from crude oil. These types of refineries also manufacture lubricants, waxes, and special products in addition to the several oil fuels. The smaller refineries confine their operations to the recovery of gasoline by straight run distillation together with the recovery of kerosene, gas oil and distillate fuel, and residual fuel oils.

The largest aggregate and individual refinery capacities are located in the Chicago industrial area, which includes Lockport and Joliet. Refineries in the Chicago district have four pipeline connections with producing fields in Texas, Oklahoma, and Kansas. Since the development of the Illinois basin fields, pipeline connections have been established.

Refineries by Market Groups in the Central Refining District.*

Group	Capacity (Barrels per day)	Cracking Capacity
Chicago district (Illinois & Indiana)	266,500	57,810
Southeastern Illinois	26,000	7,200
Western Illinois (E. St. Louis-Wood River)	66,910	27,610
Kentucky	28,600	8,150
Michigan	68,350	10,050
Ohio, Lake Erie ports	64,500	28,700
Ohio, interior	11,900	2,700
Ohio, Cincinnati	18,000	8,000

*Petroleum refineries, including cracking plants, in the United States, January 1, 1938: U. S. Bureau of Mines Inf. Cir. 7034, 1938.

Refineries in the southeastern Illinois field have a daily capacity of 26,000 bbl. and a cracking capacity of 7,200 bbl. daily. The refinery at Lawrenceville, with a capacity of

Approximate depths to principal producing horizons in the Illinois oilfields.*

Geologic system or formation			Colmar-Plymouth	Dupo	Carlyle-Bartelso	Centralia	Lake Centralia - Salem	Dix	Patoka	St James	Beecher City - Louden	Central Basin Area	Southeastern Illinois
PENNSYLVANIAN		Pottsville											Robinson and Bridgeport sands 1000' Buchanan - 1250'
MISSISSIPPIAN	Chester	Cypress			Carlyle sand 1000	Cypress 1200				Weiler 1600'	Weiler sand 1510'	Weiler sand 2600'	Kirkwood sand 1500'
		Bethel				Benoist 1350'	Benoist 1770'	Benoist 1950'	Benoist 1420'		Benoist 1540'		Tracey sand 1600'
		Aux Vases					Aux Vases 1800'					Bradley sand 2990'	
	Ste Genevieve	Fredonia					McClosky "sand" 2000					McClosky sand: Clay City 2980', Noble 2960', Olney 3050', Schnell 3010', Flora 2970', Clone 3120', Aden 3290', N. Aden 3310', Leech Twp. 3450'	McClosky "sand" 1700'
DEVONIAN			Hoing sand 450'										Martinsville pool "Niagaran" 1550'
ORDOVICIAN				"Trenton" 500									Westfield pool "Trenton" 2260'

* Several fields, having only one to four wells each are not included

16,000 bbl., is connected with the Mid-Continent field through the Texas Empire Pipe Line Company and with the Illinois basin fields through the Central States pipeline. The refinery in Robinson has depended mainly on local crude oil supplies but is connected with the Mid-Continent through the Illinois Pipe Line Company.

Refineries in the Wood River crossing and East St. Louis district are served by three pipelines from the Mid-Continent with connections in Kansas, Oklahoma, and Texas. Pipeline connections also have been established between the Illinois fields at Centralia and Salem via the Illinois Pipe Line Company to the refinery at East St. Louis via the Wood River connection.

Refineries in Kentucky are all small, the largest being at Latonia (near Cincinnati), Ohio, with a daily capacity of 8,000 bbl. This refinery is served by a branch line of the Illinois Pipe Line Company with connections in the Mid-Continent field. The remaining refineries probably serve a local market and do not extend their activities into the Illinois basin area.

The Michigan refineries are mainly small plants; the largest refineries have a daily capacity of 8,000 bbl. with an average daily capacity of less than 3,000 bbl. Michigan petroleum, in addition to a market outlet in the refineries in the field, is also carried by pipeline to Detroit, Toledo, Port Huron, and Canadian refineries.

In western Ohio, the largest refineries are in the Toledo district. These refineries have pipeline connections with the Mid-Continent, the Michigan fields, and the Illinois basin. The refineries in west-central Ohio, located at Lima and Findlay, have a capacity of 11,900 bbl. Pipeline connections with Illinois basin fields and the Mid-Continent provide the source of crude petroleum.

The refinery at Hooven (near Cincinnati), Ohio, has a capacity of 18,000 bbl. daily. This refinery receives its supply of crude by the Gulf Refining Company pipeline from the Mid-Continent territory.

The central refining district possesses approximately 14 percent of the crude oil refinery capacity in the United States.

Crude Runs-to-Stills in the Central Refining District, 1936-1938*

Year	Central Refining District	United States	Percent
	(1,000 bbl.)		
1936	147,724	1,068,570	13.9
1937	164,243	1,183,440	13.9
1938	159,446	1,165,015	14.1

*Data from Minerals Yearbooks, U. S. Bureau of Mines

Crude petroleum to supply refineries in the district is obtained from the oil producing fields of Illinois, Michigan, Indiana, Kentucky, and Ohio, and from the Mid-Continent fields, principally from the states of Oklahoma Kansas, and New Mexico. Smaller quantities are obtained from Texas.

Crude Oil Shipped From Principal Oil Producing States to Central Refining District in 1937*

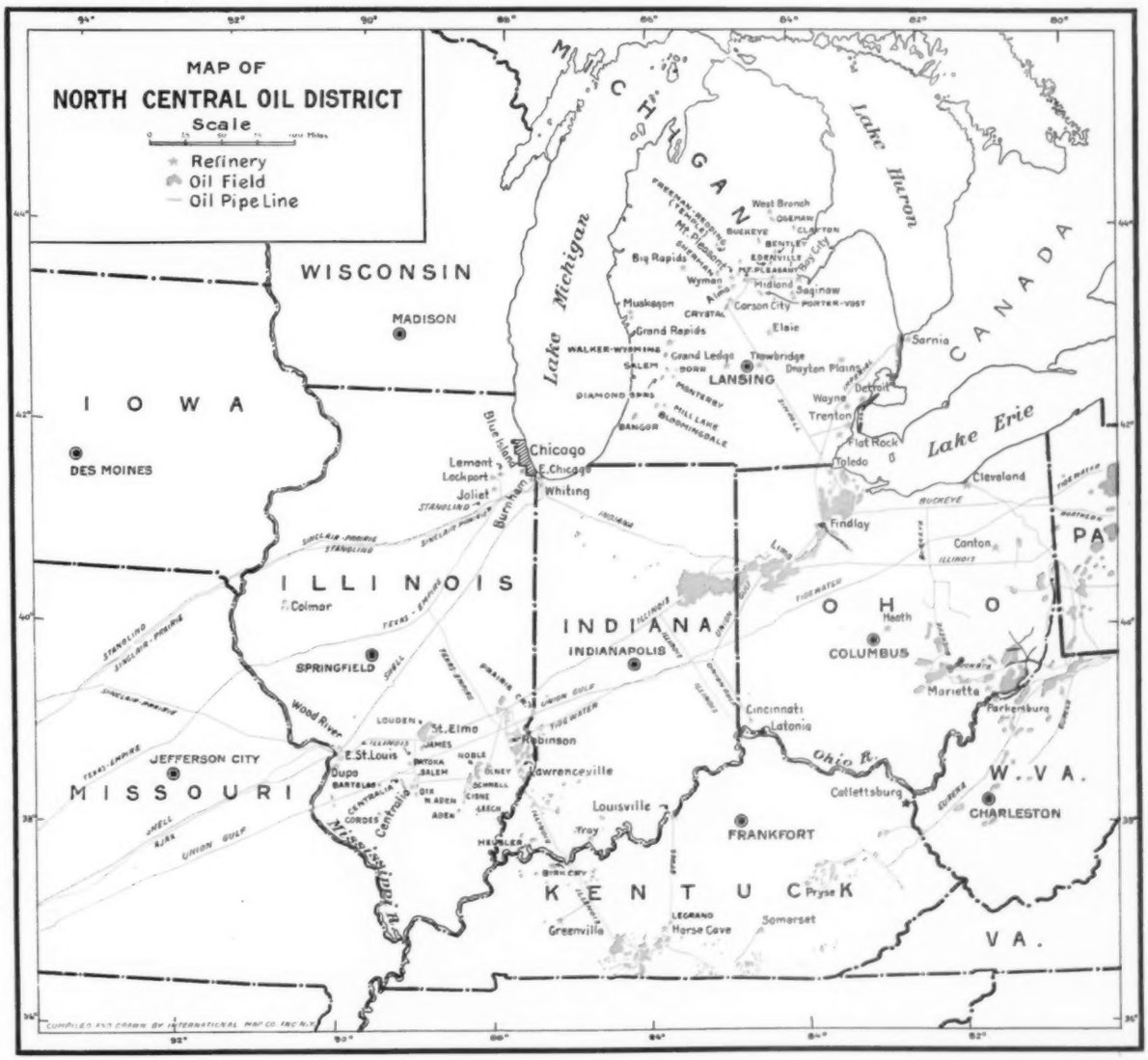
State	Quantity shipped	Percent of state output
	(1,000 bbl.)	
Texas	12,474	2.4
Oklahoma	85,795	37.5
Kansas	26,727	37.8
New Mexico	10,260	26.4
Total	135,256	

*Minerals Yearbook, 1938, U. S. Bureau of Mines

Approximately 160,000,000 bbl. of oil is refined in the central refining district annually. The record for the past three years shows a rise from 148,724,000 bbl. in 1936 to 164,243,000 bbl. in 1937, while the figure for 1938 was 159,446,000 bbl.

Of this quantity, the four leading states of the Mid-Continent field supplied 135,000,000 bbl. in 1937, or 82 percent. These states have been the principal source of crude oil supply.

With the rapid rise of oil production in Illinois, competition for the disposal of crude oil in the central refining district was felt by producers in the Mid-Continent states. The development of this competition may be measured roughly by a comparison of Illinois production with runs-to-stills in this district.



Map showing the relation of the Illinois oilfields to crude oil pipelines, refineries and producing areas in the north central states.

OIL AND GAS PRODUCING STRATA IN ILLINOIS

System or Series	Formation and Lithology*	Local Name and Area Productive
Pleistocene		Gas from glacial drift
Pennsylvanian	McLeansboro - sh., ss., thin ls., and coal	Upper Siggins, Gas - Clark County fields
	Carbondale - sh., ls., ss., coal	Casey, Claypool, Upper Partlow, Lower Siggins, Bellair 500 - Clark County Dykstra, Wilson - Marion County
	Pottsville - ss., sh., and thin coal	Lower Partlow - Clark County Robinson - Crawford County Bridgeport - Lawrence County Buchanan - Lawrence County Biehl & Jordan - Wabash County Petro - Marion County
Chester (Upper Mississippian) Series	Kinkaid - ls., sh. Degonia - ss. Clore - ls., sh. Palestine - ss. Menard - ls., sh. Waltersburg - ss. Vienna - ls., sh. Tar Springs - ss. Glen Dean - ls., sh. Hardinsburg - ss. Golconda - ls., sh. Cypress - ss. Paint Creek - ls., sh. Bethel - ss. Renault - ls., sh., ss. Aux Vases - ss.	Carlyle - Clinton County Kirkwood - Lawrence County Upper Lindley - Bond County Weiler - Richland and Fayette Counties Stray - Fayette County Tracey - Lawrence County Benoist - Clinton, Fayette, Jefferson and Marion Counties Aux Vases - Marion County Bradley - Wayne County
Iowa (Lower Mississippian) Series	Ste. Genevieve - ls. (Levias - ls.; Rosiclare - ss.; Fredonia - ls.) St. Louis - ls. Salem - ls. Warsaw - ls. Keokuk - ls. Burlington - ls. Fern Glen - ls. (Osage group) Kinderhook - sh., ls., ss.	Rosiclare - Jefferson County McClosky sand - Illinois basin and southeastern fields Westfield lime - Clark County Mississippi Lime Carper sand - Clark County
Mississippian and Devonian	Chattanooga - New Albany sh.	
Devonian	Limestone	Niagaran Martinsville pool - Clark County Hoing sand Colmar-Plymouth field - McDonough County (Hunton limestone of Oklahoma)
Silurian	Dolomite	
Ordovician	Maquoketa - sh. Kimmswick - ls. Plattin - ls. Joachim - ls. St. Peter - ss.	Trenton Westfield pool - Clark County Dupo field - St. Clair County (Viola limestone of Oklahoma) (Wilcox sand of Oklahoma)

*ls. - limestone; ss. - sandstone; sh. - shale

Setting up collar on bit sub. in the Louden field near St. Elmo, Illinois.

Percentage of Illinois Production to Runs-to-Stills in the Central Refining District, 1937-1939*

Month	Runs-to-stills	Illinois production	Percent
	Thousands of barrels		
January, 1937	13,192	368	2.79
July, 1937	14,644	530	3.68
January, 1938	13,567	1,128	8.31
July, 1938	13,955	1,642	11.10
January, 1939	14,370	4,446	30.90
February, 1939	13,514	4,542	33.60
March, 1939	14,919	5,380	36.10

*U. S. Bureau of Mines, Monthly Petroleum Statements

The discovery of oil in the deep basin of Illinois brought about a critical condition with respect to market outlets. Pipeline facilities were either inadequate or lacking altogether. Immediately prior to the discovery of oil in the basin fields, production of the old southeastern field was processed mainly in the Ohio Oil Company refinery at Robinson. There were, during the early stages of development, no pipeline connections with large refineries in the Chicago district, in western Illinois, or the refineries in western Ohio.

This condition was corrected to some extent by the construction of gathering and trunk pipelines and the reversal of flow in existing pipelines so that connections are now established with refineries in Lawrenceville, East St. Louis, Lemont, and Lockport from the Clay City and Noble fields, the Salem (Lake Centralia) field, the Louden (Beecher City) field and the Sandoval and Patoka fields. The pipeline capacity, if given preference for Illinois oil, would probably be adequate to handle the present production. Pipeline service, however, is of no avail to producers, unless refineries connecting with these pipelines are in the market for crude oil. The practical advantage of pipeline facilities lies with those producers who are affiliated with refineries. It is natural, therefore, where there are a large number of independent producers, in a new producing district, that some among them have difficulty in finding outlets for their production.

Although crude petroleum is transported by tank car to a certain extent, particularly from newly developed fields, the most economical method is either by pipeline or water transportation. For economical movement of Illinois oil, the ultimate aim will be to effect transportation by pipeline, except in cases where refineries are located in the field itself. It is, therefore, of interest to survey the extent of refining capacity in the Illinois field and that connected by existing pipeline facilities.

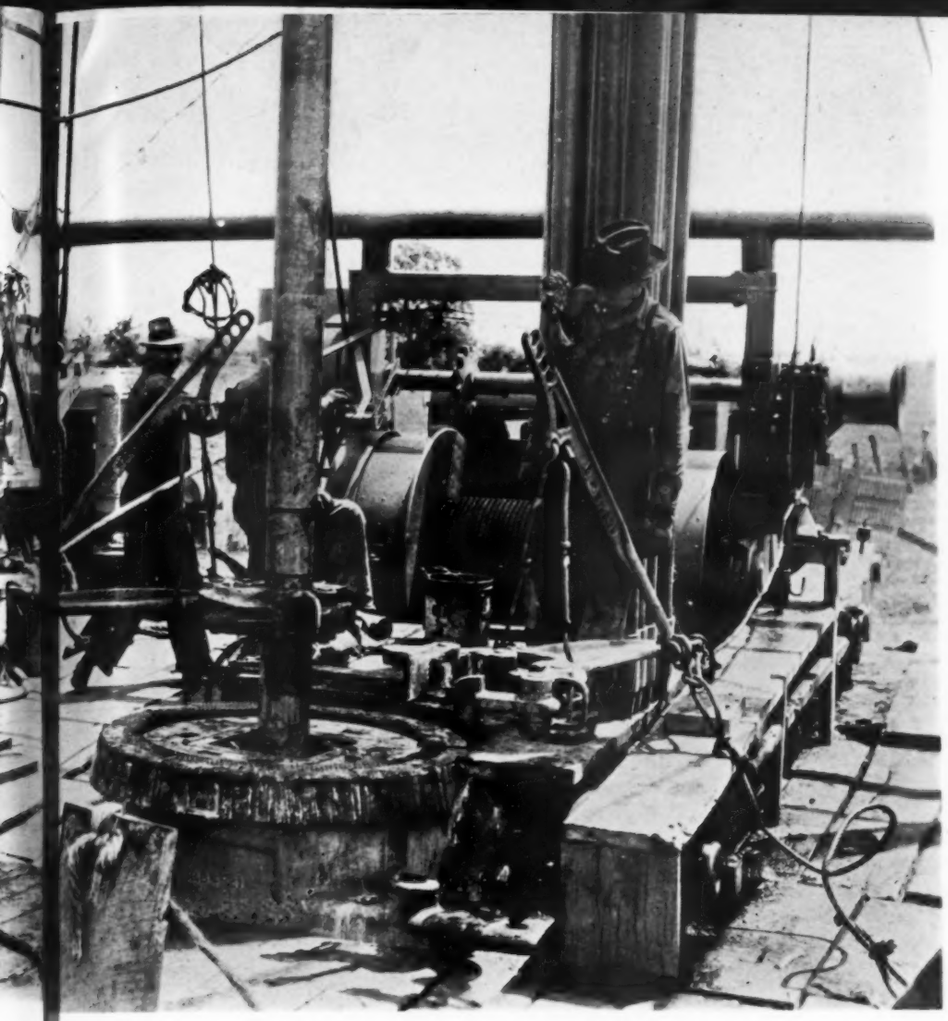
Refineries located in the field at Centralia and St. Elmo have an aggregate estimated capacity of 10,000 to 12,000 bbl. daily, although exact data on capacities have not yet been announced.

Refineries with pipeline connections to which Illinois oil is now being shipped are located in Illinois and Ohio. Refineries in Illinois have a total operating capacity of 136,410 bbl. daily. At least four of these refineries, with a total daily capacity of 58,500 bbls. are taking part of their needs from the new fields in Illinois.

Refineries of Standard Oil Company of Ohio at Toledo and Lima, and of the Pure Oil Company at Toledo, have an aggregate capacity of 32,500 bbl. daily. Additional pipeline facilities are being constructed by the Illinois Pipe Line Company to carry Mid-Continent and Illinois crude oil to the refinery at Lima and other eastern refining markets.

In addition to these refining outlets, the pipelines facilities of the Texas-Empire Pipe Line Company are available to refineries in the Indiana portion of the Chicago district.

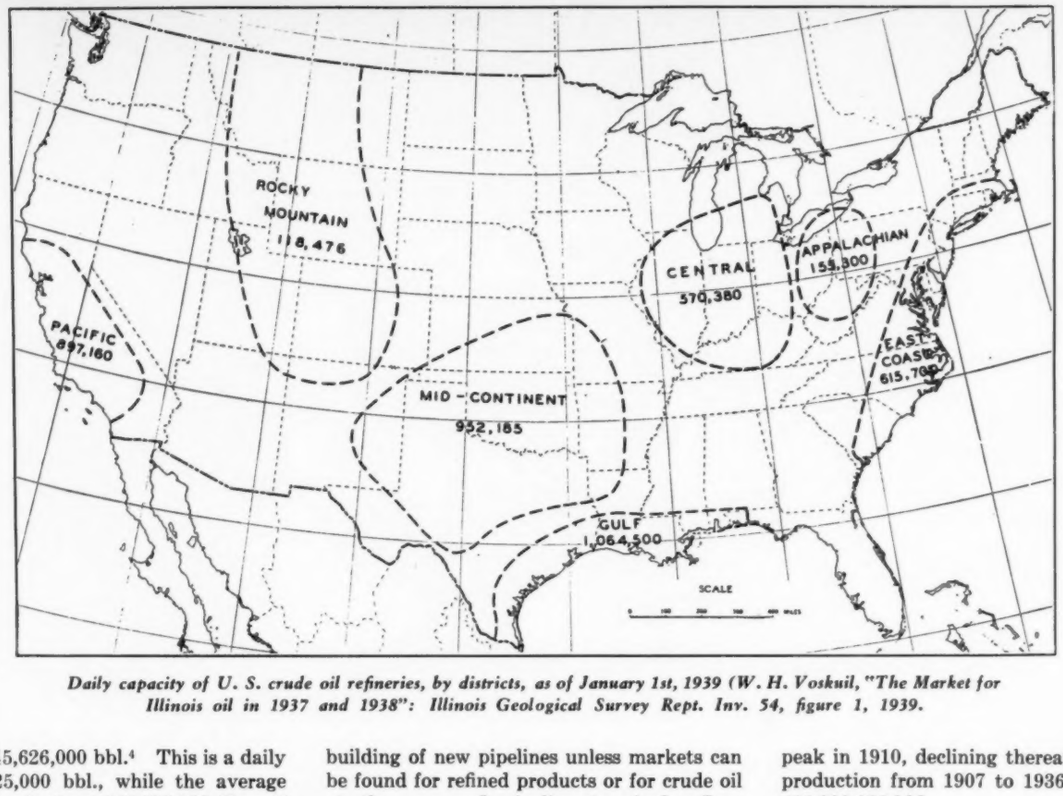
Crude oil runs-to-stills in Illinois refineries



One of the numerous spudding machines that have been designed for Illinois drilling.

Tests have been put down so close to the gravestones at Oak Grove cemetary that a fence was required to protect the burials.

Globe



Daily capacity of U. S. crude oil refineries, by districts, as of January 1st, 1939 (W. H. Voskuil, "The Market for Illinois oil in 1937 and 1938": Illinois Geological Survey Rept. Inv. 54, figure 1, 1939.

in 1937 were 45,626,000 bbl.[4] This is a daily average of 125,000 bbl., while the average daily production is about 140,000 bbl. Even if refineries used Illinois-produced oil in that state exclusively, there would still be a surplus that would need to find a market in refineries outside of the state.

While ample pipeline and refinery capacity is available in the central refining district to handle Illinois production, to do so would necessitate the displacement of this quantity of oil from the Mid-Continent fields, which would require the cooperation of the refining companies.

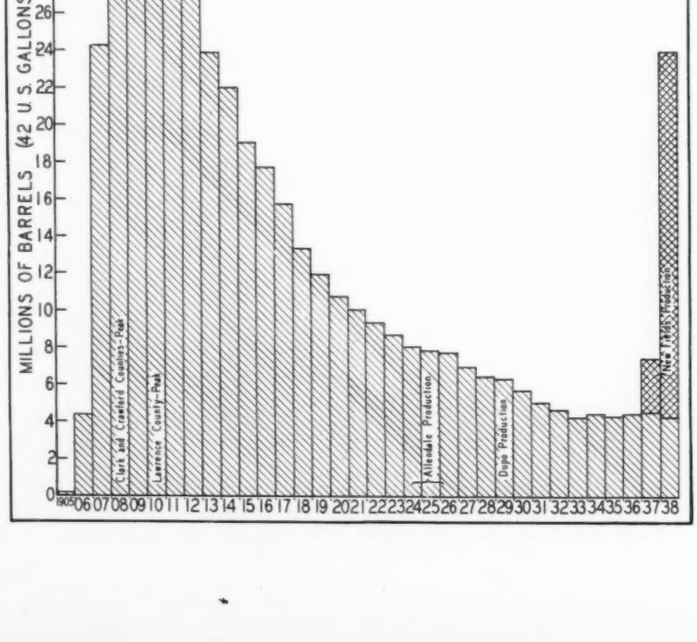
The problem of crude oil disposal will not be solved by the erection of new refineries or the building of new pipelines unless markets can be found for refined products or for crude oil at the proposed pipeline terminals. Construction of new refineries or new trunk pipelines should not be undertaken until a survey has been made of the potential supply of crude oil in Illinois and the market outlets for both crude oil and refined products.

The prospect in Illinois is one of sustained production for several years. The short time prospect is one of an increase above current levels. In this connection, the history of production in the old Southeastern Illinois field may throw light on the possible duration of high productivity in the new field. Production in significant quantities in the old field began in 1907, reached a peak in 1908 and a secondary peak in 1910, declining thereafter. The total production from 1907 to 1936 inclusive was 421,000,000 bbl.

During a period of 30 years, the old fields produced 421,000,000 bbl. of which nearly two-thirds was recovered in the first 10-year period. The average daily output for the peak year of production in 1908 was 92,300 bbl. To what extent the performance of the new fields will simulate that of the old fields cannot yet be forecast. The present estimate of reserves of the order of 400,000,000 bbl. cover only proved areas and make no allowance for untested areas. Since the Illinois basin fields have not been definitely outlined, a forecast of the probable maximum daily output and of the duration of sustained production at the average current daily level cannot be made. Further discoveries, both in new areas and in deeper horizons of proved areas, are possible. Nevertheless, the extent of known reserves together with the rate of drilling and the number of producing wells drilled indicate a high rate of production for the years immediately ahead.

[4]U. S. Bureau of Mines, Minerals Yearbook, p. 846, 1938

Annual production of crude oil in Illinois, 1905 to 1938. Present indications are that the production for 1939 will be more than double that of 1908.



Production of Petroleum in Illinois, 1907-1916, Inclusive.*

Year	Production Thousands of barrels	Percent of total production	Cumulative production Thousands of barrels	Cumulative percent of total production
1907	24,282	5.8	24,282	5.8
1908	33,686	8.0	57,968	13.8
1909	30,898	7.2	88,866	21.0
1910	33,143	8.0	122,009	29.0
1911	31,317	7.5	153,326	36.5
1912	28,602	6.5	181,928	43.0
1913	23,894	6.0	205,822	49.0
1914	21,920	5.0	227,742	54.0
1915	19,042	4.8	246,784	58.8
1916	17,714	4.2	264,498	63.0

Total production, 1907-1936..... 420,961

*U. S. Bureau of Mines, Minerals Yearbook, 1937, p. 1, 008

As a consequence of an expected period of sustained production from Illinois fields, a readjustment of present channels of crude oil flow from Mid-Continent producing districts to refineries in the central refining district will become necessary. The principal Mid-Continent oil-producing states that will be affected are Oklahoma and Kansas, and to a lesser degree, New Mexico.

WORLD PETROLEUM REGISTER

A VOLUME which easily ranks as the oil man's most useful reference book is WORLD PETROLEUM REGISTER, just published. The current issue represents a combination of World Petroleum Directory and The Petroleum Register, which formerly were published separately. It includes the best features of its predecessors and presents information on the production, transportation, refining and marketing activities of oil companies in every part of the world, with detailed summaries of their financial structures and operations. Such features as the lists of tankships, bunkering stations, drilling contractors, royalty companies, trade associations, professional and scientific experts and an elaborate buyers' guide enable the user to inform himself quickly on any phase of oil industry activity in any part of the world.

Particular attention has been given to the arrangement of material for greatest convenience in consultation. Although the new volume contains 200 pages more than any previous petroleum register, its weight and bulk have been kept to a minimum by use of special thin paper and by more rigid condensation of material both in editing and typography. Improvements have been made in the arrangement of contents and index pages and a thumb index system for the main section enables one to turn readily to any general subdivision which it is desired to consult. It is obvious that no effort has been spared by the REGISTER'S editors in collecting, compiling, checking and arranging information for this volume.

WORLD PETROLEUM REGISTER is published by Russell Palmer at $10. Copies may be ordered through the offices of WORLD PETROLEUM in New York, London, or Los Angeles.

NEGOTIATIONS regarding its concessionary areas in the Dominican Republic were completed early in June, 1939, by Compania Seaboard Dominicana de Petroleo and the government officials at Ciudad Trujillo. With the co-operation of the government, it had been possible to wind up the litigation, and on July 3rd the company spudded its first test on the Meleta dome.

The 126 ft. steel derrick is rigged for a possible depth of 6,000 ft.—although it may not be necessary to drill that deep. The surface casing used is 20 in. in diameter. Before the end of two weeks, the well had reached 764 ft., but progress is expected to be slower in the future because of the desirability for frequent coring.

Three minor shows of oil and gas have been obtained. This was anticipated in light of the information made available by the nearby Smith well, drilled to 2,900 ft. on nearby Moleno structure in 1927.

Whether or not oil is obtained in commercial quantities by Seaboard's Meleta test, another wildcat probably will be sunk in the Monte Cristi region where the company's geological parties have discovered interesting structures.

Architect's drawing of the proposed International Building planned for the 1940 International Petroleum Exposition at Tulsa, Oklahoma, U. S. A., providing enough nations of the world will accept the show's invitation to exhibit bas-relief maps of their oilfields. There will be no charge for space. The building will also be headquarters for international delegates.

IN PREPARING the plans, now well advanced, for next year's petroleum exposition at Tulsa, Oklahoma, special emphasis is being placed on the international character of the oil industry. Invitations have been issued to all oil producing nations to participate in the exposition both by sending delegates and by arranging exhibits. Leslie Brooks, publicity director, with the cooperation of the U. S. State Department, personally presented the proposal to the diplomatic representatives of 26 governments. Acceptances have now begun to reach W. G. Skelly, exposition president.

If a sufficient number of countries indicate their intention of providing displays, a new building to be known as the International Building will be erected to house these exhibits and to serve as headquarters for overseas visitors. A special committee with James H. Gardner, president of Gardner Petroleum Company of Tulsa, is at work providing accommodations for the large number of international representatives expected to attend the exposition and arranging tours for the visitors to production areas, refineries and gasoline plants.

Preliminary reports to the exposition authorities in Tulsa show that a cordial reception is being given to the plans for making the 1940 exposition more world-wide in scope than its predecessors and indicate that the movement will be highly successful.

DEPOSITS of bituminous shale have been discovered recently in many places in the Grodno region of Poland. An examination of specimens by the Warsaw Institute for Chemical Research has established the presence of 39 percent of combustible constituents, a much higher percentage than that in the Estonian bituminous shale, the industrial exploitation of which is the main asset of that country. The shale deposits of the Grodno region are found at a depth of only six feet under a layer of clay, and extraction apparently would be possible by cheap excavation.

Snider-Triangle

Originality in overcoming strong gas pressure problems struck a new note in the Montebello field, California, when the Pongrantz well recently got out of control while being deepened. A wind-machine used by the motion picture industry to create storm scenes was borrowed by the drillers and is shown blowing the gas back from the well to reduce danger of explosion and permit the men with gas masks to work beneath the derrick floor in order to shut off the flow.

I. P. C. To Build Second Mediterranean Pipeline

FIRST indication of the early duplication of Iraq Petroleum Company Ltd.'s Mediterranean pipeline, from the Kirkuk oilfield to marine terminals at Haifa and Tripoli, was the announcement in Baghdad of a modified agreement with the Iraq government and the company's decision to increase output. A wireless report from London now states that very shortly bids will be called for supply of pipeline materials.

Although final decision had not been made at the time of writing, it is probable that 850 mi. of pipe will be ordered for the Kirkuk-Tripoli pipeline and 350 mi. for the southern bifurcation. The two branches of the new 16 in. line are expected to handle 3,000,000 tons and 1,000,000 tons, respectively. Pumps will be Diesel driven, as in the case of the existing outlet.

The original pipeline, completed in 1934, has a rated capacity of 4,000,000 tons per annum, although, in fact, exports in recent years have exceeded this figure. Construction of this line presented many problems which are not likely to be encountered when work gets under way on the new project. Previously, it was necessary to establish lines of communication, to build camps, supply depots and hospital facilities, to organize a transport service adapted to local conditions, and to build roads along which the trucks might travel. Apart from this, friendly relations had to be established with the Bedouin tribes.

Construction of the 1,180 mi. main pipeline in 1932-1934 required the importation of more than 200,000 tons of building materials and company's motor transport service moved an aggregate of nearly 25,000,000 ton miles. The total cost of construction was about £10,000,000.

Alterations in the conventions of two of the three oil companies in the I.P.C. group operating in Iraq were made recently, preceding announcement of the pipeline expansion.

Under the agreement, which was submitted to the Baghdad Parliament for ratification during June, an interest-free loan of $15,000,000 (£3,000,000) is to be granted by the company to the Iraq Government. The main amendment to the former agreement is the deletion of paragraph five, article six, which stipulates that "at least 50 percent of the capacity of the whole pipeline system shall be carried to the terminal in the Bay of Acre (Haifa)." The effect of the new arrangement is that the I.P.C. may send its oil from Kirkuk to either terminal, Haifa or Tripoli, in any quantity it chooses.

The new agreement also makes an important concession to B.O.D. Company, Ltd., operating the Mosul oilfields, which were due to start oil exports in October, 1939, by extending its non-production period for a further seven years. It will begin regular exports in 1946, about the same time as Basrah Petroleum Company, Ltd.

Moreover, article five of the B.O.D. convention, providing for drilling operations "with a minimum of three rigs, and within one year after oil being struck will increase to nine rigs . . . until the commencement of regular exports of oil," has now been entirely deleted. It has been replaced by the stipulation that the company must drill at a minimum rate of 12,000 ft. a year without specifications as to the number of rigs.

It is understood that the £3,000,000 loan will be supplied to Iraq at the rate of £1,000,000 a year. The Iraq Government will repay the loan from Iraq Petroleum Company royalties when they exceed the present yearly amount of about $4,000,000 (£800,000 gold).

British Combine

Loading oil on a French tanker at Haifa.

EXCESS RUNS TO STILLS

May Check U.S. Companies' 1939 Earnings

By Henry E. Rose

WHILE the American petroleum industry made reasonable profits in the first six months of this year, in spite of an adverse statistical condition, it is evident that certain corrective measures will have to be undertaken promptly if it hopes to be in a sound economic status for the new heavy gasoline consuming period next year.

During the first six months of 1939, the industry, taken as a whole, earned from 30 percent to 35 percent less than in the corresponding period of 1938. Had it not been for the realization last March that higher prices were necessary for gasoline, the money product, in order to support refining and marketing operations, the income accounts would make cheerless reading.

For several months the industry has been processing abnormal quantities of crude oil with the result that drafts on gasoline inventories have been subnormally small. Runs of crude oil to refineries have been averaging approximately 200,000 bbl. a day in excess of economic requirements for some time, and if a satisfactory statistical position is to be attained at the end of the present heavy consuming period (October 1st), it is obvious that drastic curtailment must be made in refinery operations.

Because of these heavy crude runs, withdrawals of gasoline from storage stocks, which had been built up during the fall and winter of 1938 and early 1939, in anticipation of summer demand, have been running approximately 45 percent less than in 1938. From April 1st to July 15th of this year, which represents slightly more than one-half of the heavy consuming period, the drain on gasoline inventories amounted to only 7,705,000 bbl. against 13,627,000 bbl. in the similar period of last year. In recent weeks, total stocks of finished and unfinished motor fuel, in consequence of small withdrawals, have been in excess of the same time a year ago, a contra-seasonal trend. The showing, too, is in face of a new record demand for gasoline, with consumption this year surpassing that in 1938 by more than four percent.

Economists estimate that gasoline inventories, to be in a sound statistical position on October 1st, next, should not exceed 62,000,000 bbl. In order to reach that goal it will be necessary to liquidate from inventories at least 17,400,000 bbl. after July 15th, or approximately 80 percent more than was withdrawn in the similar period of 1938 (9,607,000 bbl.). With present high runs to refineries, or even with moderate curtailment, it is evident that this objective will not be attained. In fact, the indications are that these stocks on October 1st will be from 8,000,000 to 10,000,000 bbl. higher. A burdensome position will have been built up which, with additions during the fall and winter, might react unfavorably on price levels next spring. Current stocks are estimated to represent a surplus of 10,000,000 bbl.

This year's gasoline demand, including exports, in the first six months, probably approximated 280,000,000 bbl. which would compare with 268,671,000 bbl. in the similar period of 1938, an increase of better than four percent. Domestic demand, taken alone, showed an even larger gain.

The realization on the part of the refining division that it would have to receive better prices for gasoline to recover its crude oil costs became apparent early in March, although not in time to aid profits for the first quarter. The price improvement continued until late in June and has been maintained up to the present. Prices, however, are below those of a year ago for wholesale and tank wagon deliveries. Present quotations average about ½ cent per gal. less than a year ago. That ½ cent per gal. would add another $110,000,000 a year to oil companies' revenues and permit of a much better profit showing.

Subnormally low prices for gasoline in the first quarter of this year caused profits of the industry, in the aggregate, to run about 62 percent smaller than in the corresponding three months of 1938. The improvement in prices in the June period enabled a materially better showing as evidenced by the fact that the reduction in earnings was narrowed to from 30 percent to 35 percent in the first six months as compared with a year ago. June quarter profits, taken alone, ran materially ahead of those in the March quarter.

Present uncertainties—high runs of crude oil to refineries and unseasonally large stocks of gasoline, tending to exert pressure on both gasoline and crude oil prices—make it difficult to forecast, with any degree of confidence, as to the profit outlook. If gasoline prices hold through this quarter, as is the hope in some quarters, profits will be higher than in the three months ended June 30th since, normally, this is the period of heaviest consumption. If excessive refinery runs continue, it is almost a certainty that a reaction on prices will develop, which, in turn, may be reflected in lower prices for crude oil.

At present, because of the maladjustment of crude supply sources, caused largely by the rapid development of Illinois fields, it is estimated that approximately 180,000 to 200,000 bbl. of crude oil are moving at levels below the highest posted prices in various fields. This condition exists not only in Illinois, where roughly 25 percent of that state's crude output is being sold at discounts, but also in Louisiana, Arkansas, Oklahoma, Texas and Kansas. Expressed differently, about five percent of the country's production of crude is moving below scheduled price levels, which is an unhealthy condition. This amount of crude, incidentally, was sufficient to cause a general reduction in crude prices in October, 1938.

To some in the industry there is hope that corrective measures to stabilize the industry will be taken in time to avert a collapse in prices. If it does not materialize, undesirable consequences may result. A crisis in the fall, when demand for gasoline begins to taper off, and stocks again accumulate more rapidly, is not entirely ruled out.

While production of crude oil for the country, as a whole, has been in balance with demand, this position has been achieved solely at the expense of drastic proration restrictions in Texas and Oklahoma. Meanwhile, production in Illinois is increasing steadily and new records are being marked up. Present output in Illinois of around 270,000 bbl. a day compared with only 45,000 bbl. a year ago. There is no conservation statute in that state although feeble efforts were made early this year in that direction.

The situation in Illinois is largely responsible for the present unsettlement in Mid-Continent states, since some of the latter's mid-western markets are being taken over gradually by Illinois production. There have been indications recently that Illinois plans to give more serious consideration to conservation and the hope is entertained that it may be enacted at the next legislative session. This step alone, in the opinion of oil executives, could avoid a price cut.

Michigan, which has been conducting a broad development program and increasing its potential production considerably this year, adopted a conservation measure a few months ago and there is no fear of overproduction in that state. California also has taken its production question in hand.

From one viewpoint, the crude picture has been misleading. It is in the amount of crude oil in storage above ground. Such stocks, in recent weeks, reflecting the high rate of refinery runs, have been going through a process of reduction. On July 8th they totaled 269,369,000 bbl., and were at the lowest level in 17 years. In effect, the crude is being converted into refined products, with stocks of the latter accumulating.

Of 28 companies, whose shares are listed on leading stock exchanges, 23 showed profits in the first quarter of this year and the remaining five deficits. The aggregate profits were $13,379,787 compared with $35,979,060 in the similar period of 1938, a reduction of 62 percent. For individual companies, the diminution in earnings ranged from 11 percent to 84 percent, the solely producing companies making the best showings. Mid-Continent integrated companies suffered most severely because it was in that area that prices for

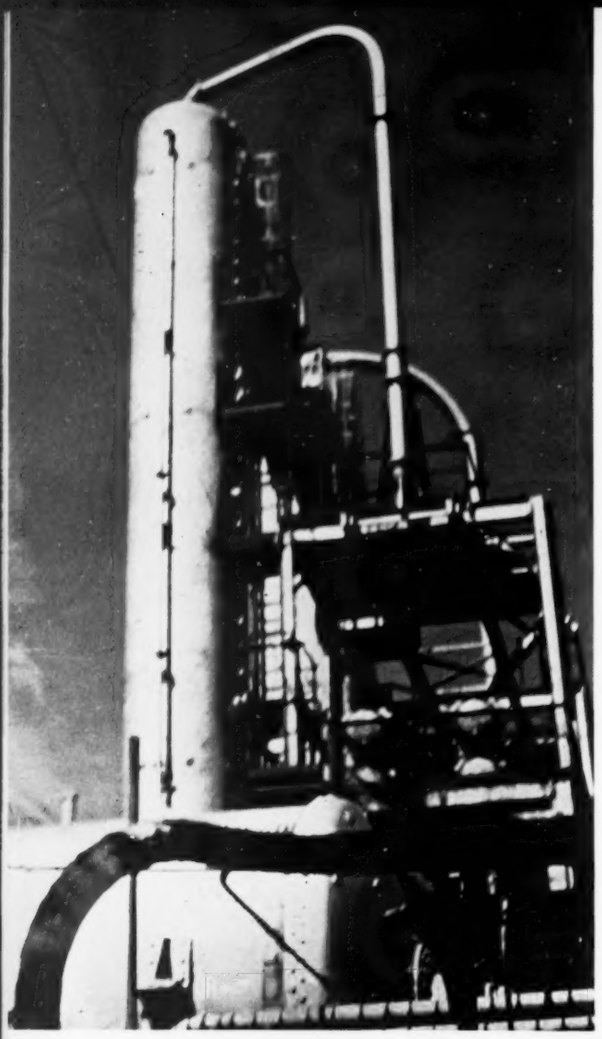
FIVE YEAR FINANCIAL REVIEW

	Net Income	Per Share of Com.	Net Working Capital	Net Capital Assets	Funded and/or Long Term Debt	No. of Pref. Shares	No. of Com. Shares	Surplus
Amerada Corp.								
1938	$1,634,486	$2.07	$3,680,800	$51,622,754	.....	.....	788,675	$4,922,742
1937	2,400,028	3.04	3,714,837	11,684,811	.....	.....	788,675	5,055,621
1936	1,983,901	2.52	4,183,364	10,426,074	.....	.....	788,675	4,232,943
1935	1,797,613	2.28	5,008,667	9,227,589	.....	.....	788,675	3,826,392
1934	1,736,420	2.20	5,096,673	8,966,293	.....	.....	788,675	3,606,129
Atlantic Refining Co.								
1938	4,310,913	1.40	40,723,724	142,172,139	25,406,849	148,000	2,663,999	73,270,967
1937	9,935,045	3.51	22,824,810	134,126,471	508,858	148,000	2,663,999	71,733,501
1936	7,342,197	2.59	34,627,900	113,737,073	522,793	148,000	2,664,000	64,841,504
1935	3,970,598	1.49	36,512,103	111,157,824	14,023,623	.....	2,664,901	65,617,388
1934	5,512,105	2.07	37,960,843	109,739,314	14,024,734	.....	2,664,902	66,791,823
Barnsdall Oil Co.								
1938	2,837,894	1.26	2,884,341	11,416,400	5,000,000	.....	2,250,344	5,947,243
1937	1,903,029	.84	1,465,258	11,628,526	3,861,743	.....	2,250,344	6,396,684
1936	2,262,544	1.00	4,611,623	10,044,519	5,000,000	.....	2,247,974	7,471,507
1935	741,136	.34	2,152,780	7,659,141	.....	.....	2,131,090	7,256,270
1934	(d) 1,029,447	....	3,719,365	14,968,355	318,510	.....	2,205,451	9,096,713
Consolidated Oil Corp.								
1938	7,737,712	.55	97,874,488	201,583,988	72,179,196	.....	13,751,846	187,049,022
1937	20,809,295	1.44	78,130,681	209,354,872	48,564,969	54,491	13,915,617	190,874,640
1936	16,728,929	1.18	78,118,866	204,171,446	49,720,570	56,592	13,944,886	182,866,672
1935	11,306,904	.74	78,377,440	200,965,255	40,181,938	106,028	13,983,237	180,540,203
1934	553,282	(e) 5.43	75,099,378	208,402,801	47,343,015	101,844	13,996,172	175,399,011
Continental Oil Corp.								
1938	5,139,755	1.10	45,753,061	55,862,435	21,071,600	.....	4,682,581	69,591,015
1937	13,948,460	2.98	30,395,524	50,970,433	.....	.....	4,662,388	69,133,647
1936	9,612,597	2.05	28,749,999	45,374,654	.....	.....	4,738,593	61,875,373
1935	8,813,561	1.88	31,154,643	39,825,881	.....	.....	4,682,664	56,880,127
1934	4,865,351	1.03	25,390,339	40,647,154	.....	.....	4,738,593	51,780,703
Creole Petroleum Corp.								
1938	11,464,757	1.64	15,953,482	56,966,860	.....	.....	6,974,356	39,889,293
1937	11,218,752	1.61	17,073,570	52,162,879	.....	.....	6,974,356	35,638,823
1936	8,596,448	1.23	14,757,203	51,304,681	.....	.....	6,975,383	32,469,427
1935	5,509,067	.79	8,229,979	52,877,364	.....	.....	6,974,356	27,357,909
1934	5,315,254	.76	5,174,439	51,926,430	.....	.....	6,974,356	22,657,566
Gulf Oil Corp.								
1938	13,017,076	1.43	126,830,235	350,468,996	75,613,092	.....	9,076,202	115,308,601
1937	31,854,065	3.51	118,361,299	339,864,527	79,913,155	.....	9,076,202	125,071,106
1936	26,356,003	2.90	81,837,311	313,146,546	73,605,813	.....	9,076,202	102,756,263
1935	10,551,720	2.32	96,410,624	288,757,680	87,166,000	.....	4,538,101	199,049,566
1934	2,811,183	.62	97,615,006	283,076,187	91,629,847	.....	4,538,101	189,737,462
Humble Oil & Refining Co.								
1938	35,800,354	3.98	37,440,543	295,440,883	42,640,805	.....	8,987,840	120,663,584
1937	46,924,001	5.22	8,245,084	269,905,258	1,648,181	.....	8,987,840	103,172,103
1936	34,183,527	3.80	26,962,743	226,310,687	266,945	.....	8,987,840	74,846,370
1935	23,966,326	2.66	29,002,746	204,138,789	487,610	.....	9,000,000	53,499,275
1934	21,989,954	2.45	31,580,204	193,059,994	6,831,050	.....	8,968,479	38,078,401
Imperial Oil, Ltd.								
1938	25,950,380	.96	60,013,498	40,253,368	.....	.....	26,965,078	61,202,540
1937	26,442,157	.98	64,239,390	39,808,431	.....	.....	26,965,078	73,879,023
1936	25,628,285	.95	71,088,190	43,028,222	.....	.....	26,965,078	81,133,214
1935	25,229,850	.94	72,607,155	53,572,421	.....	.....	26,965,078	89,211,979
1934	25,771,653	.96	69,055,219	58,520,697	.....	.....	26,919,871	97,678,704
Mid-Continent Petroleum Corp.								
1938	1,043,791	.56	18,614,252	38,158,682	.....	.....	1,857,912	41,309,132
1937	5,304,877	2.85	18,404,109	39,090,197	.....	.....	1,857,912	42,231,402
1936	4,777,578	2.57	17,771,833	37,841,889	.....	.....	1,857,912	40,519,334
1935	2,417,175	1.31	17,132,369	36,662,598	.....	.....	1,857,912	38,311,091
1934	828,093	.45	15,133,343	36,947,518	.....	.....	1,843,872	36,893,649
1933	(d) 1,766,438	....	14,779,310	50,559,281	.....	.....	1,857,912	13,174,089
Ohio Oil Co.								
1938	4,582,964	.25	28,340,324	96,328,461	.....	354,537	6,563,377	16,231,596
1937	11,862,107	1.31	28,777,772	96,387,559	.....	548,077	6,563,377	17,710,658
1936	7,881,571	.70	32,053,658	(k) 98,929,683	.....	548,077	6,563,377	18,570,516
1935	5,488,267	.33	32,155,437	(k) 93,314,153	.....	548,077	6,563,377	17,915,323
1934	5,411,924	.32	33,740,981	(k) 95,599,183	.....	580,943	6,648,052	10,789,515
Phillips Petroleum Co.								
1938	9,049,122	2.03	43,662,204	160,683,926	41,417,920	.....	4,449,052	37,453,790
1937	24,113,874	5.42	30,657,681	158,719,012	25,613,235	.....	4,449,052	37,302,764
1936	17,875,489	4.22	23,362,194	146,812,781	14,009,257	.....	4,449,052	29,153,170
1935	13,421,703	3.23	23,450,267	137,258,621	20,945,221	.....	4,152,836	21,954,036
1934	5,757,308	1.38	21,601,235	136,992,626	26,393,309	.....	4,153,235	13,721,113
Pure Oil Co.								
1938	5,412,903	.38	19,793,782	112,992,307	2,455,686	721,429	3,982,031	47,603,610
1937	11,403,805	2.15	26,285,254	106,907,568	2,665,760	725,431	3,738,143	46,052,869
1936	7,658,372	1.63	22,195,113	115,413,650	35,194,361	359,617	3,285,120	41,385,155
1935	8,150,026	2.00	24,685,287	110,753,615	38,743,113	309,000	3,038,700	41,728,169
1934	(d) 884,872	....	12,175,503	108,456,105	28,500,000	300,270	3,038,700	34,768,621

UNITED STATES OIL COMPANIES

	Net Income	Per Share of Com.	Net Working Capital	Net Capital Assets	Funded and/or Long Term Debt	No. of Pref. Shares	No. of Com. Shares	Surplus
Seaboard Oil Co.								
1938	$1,895,790	$1.52	$2,368,575	$2,968,905	.....	.....	$1,244,383	$2,994,781
1937	2,447,130	1.97	2,374,122	6,273,767	.....	.....	1,244,383	2,343,374
1936	2,485,675	2.00	1,726,067	5,750,047	.....	.....	1,244,383	3,084,451
1935	1,670,847	1.34	2,149,116	5,660,271	.....	.....	1,244,383	1,843,158
1934	1,375,590	1.10	2,323,826	5,523,004	.....	.....	1,244,383	1,416,691
Shell Union Oil Corp.								
1938	11,318,423	.70	84,619,113	262,819,975	82,427,000	341,100	13,070,625	17,661,533
1937	20,668,880	1.44	54,800,185	269,950,839	61,021,430	341,100	13,070,625	17,350,251
1936	22,494,364	1.57	52,628,694	262,438,076	58,764,000	343,500	13,070,625	11,579,155
1935	6,812,835	.37	41,353,931	261,648,294	50,153,979	388,166	13,070,625	3,419,589
1934	(d) 949,111	....	39,068,934	260,050,464	53,581,227	400,000	13,070,625	(d) 18,435,042
Skelly Oil Co.								
1938	2,650,055	2.27	7,588,908	44,455,396	9,026,681	64,500	995,348	24,598,248
1937	6,488,346	6.06	7,823,108	40,868,979	11,734,598	66,300	1,008,549	16,297,582
1936	4,850,314	4.42	5,476,993	38,014,854	10,852,493	66,300	1,088,549	11,647,109
1935	2,585,849	2.16	5,946,672	33,260,799	8,756,859	66,300	1,008,548	9,335,556
1934	713,577	30	5,841,952	31,527,488	9,615,679	67,000	1,008,548	(d) 2,745,942
Socony-Vacuum Oil Co., Inc.								
1938	40,106,917	1.29	224,506,869	479,173,355	127,511,486	.....	31,707,991	213,664,902
1937	56,808,264	1.82	223,646,989	457,125,753	128,063,217	.....	31,708,452	189,654,276
1936	42,909,362	1.38	166,291,713	424,296,564	68,372,972	.....	31,151,071	157,766,869
1935	22,525,892	.71	186,858,832	400,094,099	74,326,495	.....	31,708,456	146,736,060
1934	24,121,297	.76	184,148,471	400,204,514	85,014,584	.....	31,154,279	138,588,901
Standard Oil Co. of California								
1938	28,875,653	2.20	64,489,533	449,350,905	.....	.....	13,102,900	236,967,035
1937	41,254,778	3.15	61,529,257	449,046,236	494,900	.....	13,102,900	229,298,177
1936	23,310,223	1.78	58,160,244	448,223,894	5,000,000	.....	13,014,754	217,070,827
1935	18,594,330	1.42	62,647,719	445,640,587	5,000,000	.....	13,102,900	212,453,308
1934	18,327,807	1.40	80,120,833	437,191,071	.....	.....	13,102,900	211,733,009
Standard Oil Co. of Indiana								
1938	27,771,976	1.82	174,727,455	394,827,700	10,346,658	.....	15,272,020	280,850,326
1937	55,950,784	3.66	156,367,152	371,586,035	8,598,544	.....	15,267,030	284,891,637
1936	46,883,448	3.09	165,331,918	347,502,925	4,094,689	.....	15,196,241	265,367,464
1935	30,179,895	1.98	170,876,326	366,184,636	10,579,963	.....	15,215,677	253,904,946
1934	18,949,680	1.25	182,889,895	175,715,684	8,413,670	.....	15,215,677	226,267,121
Standard Oil Co. (N. J.)								
1938	76,053,170	2.86	489,684,138	1,172,251,955	192,850,833	.....	26,618,065	562,863,025
1937	147,993,147	5.64	434,929,054	1,193,534,803	139,268,806	.....	26,224,767	562,569,681
1936	97,774,583	3.73	432,337,756	1,042,421,175	84,573,564	.....	26,224,767	491,093,355
1935	62,863,192	2.43	425,337,478	1,054,520,041	82,772,730	.....	25,856,081	448,127,942
1934	45,618,960	1.76	407,165,346	1,082,380,163	141,461,816	.....	25,856,081	449,062,205
Standard Oil Co. of Ohio								
1938	1,964,605	1.81	13,719,806	42,644,255	6,929,358	120,000	753,740	19,327,778
1937	3,362,960	3.66	10,625,869	39,874,172	.....	120,000	753,740	18,682,477
1936	4,194,314	4.76	12,764,256	34,730,917	602,026	120,000	753,740	17,112,466
1935	2,690,647	2.77	11,245,428	34,427,880	741,915	120,000	753,740	15,275,632
1934	(d) 1,913,735	....	8,670,081	35,771,654	266,800	120,000	753,740	13,184,984
Sun Oil Co.								
1938	3,085,119	1.07	31,085,619	79,192,720	21,386,250	100,000	2,315,960	11,182,964
1937	9,544,085	4.17	23,813,873	74,090,757	10,330,326	100,000	2,328,330	10,953,754
1936	7,563,554	3.44	20,628,939	70,007,334	6,467,583	100,000	2,156,825	10,053,004
1935	7,100,239	3.45	20,043,466	62,787,994	6,675,681	100,000	2,030,988	9,512,101
1934	6,650,464	3.51	16,250,464	62,545,483	6,500,000	100,000	1,893,982	9,609,319
The Texas Corp.								
1938	23,139,030	2.13	113,780,180	339,074,007	62,869,727	.....	10,876,882	188,912,882
1937	54,574,319	5.02	127,058,606	329,648,904	65,667,412	.....	10,875,006	187,358,901
1936	38,260,341	4.10	93,179,802	295,631,713	88,819,129	.....	9,336,739	135,946,875
1935	17,065,037	1.83	125,756,164	257,074,288	93,253,676	.....	9,340,069	103,074,635
1934	5,545,205	.59	119,372,463	266,660,893	103,600,076	.....	9,349,733	103,232,978
Tide Water Associated Oil Co.								
1938	10,427,273	1.28	40,361,831	126,130,786	38,386,548	500,000	6,373,253	30,462,066
1937	15,801,383	2.09	42,019,706	123,923,854	39,168,798	500,000	6,369,175	28,285,935
1936	10,217,928	1.11	31,990,255	120,062,356	15,925,172	626,221	6,288,512	25,634,444
1935	7,865,701	.73	33,682,501	117,806,358	19,774,335	626,221	5,642,342	21,336,760
1934	5,810,657	.35	41,220,500	113,226,094	2,504,892	636,222	5,631,341	20,620,669
Union Oil Co. of California								
1938	6,862,758	1.47	39,408,084	115,792,578	18,018,500	.....	4,666,270	22,953,078
1937	12,061,332	2.58	41,888,136	112,174,792	18,026,500	.....	4,666,270	21,691,244
1936	6,133,398	1.40	36,147,816	107,856,361	20,326,500	.....	4,386,070	15,868,299
1935	5,038,286	1.15	35,545,741	108,543,534	21,525,500	.....	4,386,070	14,120,970
1934	2,902,733	.66	35,976,560	107,956,010	21,489,500	.....	4,386,070	13,914,222

(d)Deficit. (e) On preferred stock. (k) Exclusive of good will, patents, etc.



W. P. Staff

Liquified gas plant at Standard Oil Company of New Jersey's Bayway refinery, Elizabeth, N. J.

gasoline were especially weak. Contrariwise, the improvement in prices in the June period in the Mid-Continent, caused a reversal in the situation for companies operating there and rapid recoveries were scored in the second quarter.

In spite of the adverse profit showing in the March quarter, during which time at least ten of the leading companies failed to cover their dividend requirements for the period, there was no interruption in the regular quarterly payments. It is likely, moreover, that some companies fell somewhat short of their common dividend coverage in the June period, yet their usual payments, or the equivalent, were ordered. Changes which were made affected so-called extra or special interim payments.

Of the 25 companies used in WORLD PETROLEUM'S tabulation, all, with the exception of Skelly Oil Co., Standard Oil Co. of California and Shell Union Oil Corp., provided for the same payments this year to June 30th as a year ago.

In the case of Skelly, a payment of 50 cents on common stock was made on July 25th, 1938, characterized as an "interim" disbursement, but none has been provided to date. Standard Oil Co. of California has continued to pay regular quarterly dividends of 25 cents a share but the amount of the extra has been reduced to five cents, from ten cents a year ago. Shell Union, which disbursed an interim payment of 35 cents a common share in 1938, paid out only 25 cents this year.

Standard Oil Co. (N. J.) paid the usual semi-annual cash dividend of 50 cents plus a special of two shares for each 200 shares of stock held, thus disbursing, in value, the equivalent of the 1938 dividend.

An important development this year for oil companies has been the amount of new financing or refunding undertaken. Such financing thus far in 1939 for six major companies has entailed the sum of $271,000,000 with a deal involving probably $50,000,000 for another company pending. Financing for the first seven months of 1938, hence, including the $50,000,000 contemplated, will almost approach that undertaken by major companies during all of 1938.

The large amount of available capital funds and low interest rates are chiefly responsible for new financing for the industry which, because it is a natural resource one, must continue development work for new oil reserves and improve its refinery equipment in order to maintain its competitive position. Another reason is the curtailment in earnings in the last two years which, after dividend payments, has left insufficient capital for management to continue such development.

Socony-Vacuum Oil Co. this year has undertaken the largest refunding operation. It involved $125,000,000 of securities, of which $75,000,000 were held privately by five large insurance companies, and $50,000,000 held by the public. The $75,000,000 represented 3¼ percent debentures, due in 1955, and were refunded into 2⅞ percent debentures to run for 18 years with only four insurance companies, while the $50,000,000, which were 3½ percent debentures, were refunded into three percent obligations.

Shell Union Oil Corp., only a few weeks ago offered $85,000,000 of new 15-year 2½ percent debentures to redeem $57,427,000 of 3½ percent debentures due in 1951 held by the public and $25,000,000 of 3⅝ percent debentures due in 1953, held by an insurance company.

Texas Corp., in April, last, sold $40,000,000 of three percent debentures, due 1959, representing new financing. The proceeds were added to general corporate funds to be used in development of oil properties, refinery expansion, etc., both in the United States and abroad. Texas' total fund and/or long term debt now approximates $102,000,000, a $60,000,000 issue of 3½'s also being outstanding in the hands of the public.

Houston Oil Co. offered $10,000,000 of 15-year 4¼ percent debentures to refund $6,907,500 of 5½ percent gold bonds due May 1st, 1940, and added the remainder to general capital funds.

Phillips Petroleum Co. repaid $6,000,000 of its $15,000,000 of private borrowings and recently refunded the remaining $9,000,000 into lower rate obligations. In addition it has outstanding $25,000,000 of debentures.

Tide Water Associated Oil Co. has under consideration the offering of $50,000,000 new obligations, comprising $35,000,000 of debentures and $15,000,000 of serial notes. Proceeds, it is planned, would be used to refund $36,250,000 of 3½ percent debentures outstanding and due in 1952, and the remainder for general corporate purposes, a large part for installation of a catalytic refining process. A registration for the issues has been filed with the Securities & Exchange Commission, but the company decided, a few weeks ago, to defer the program for the present.

Giving effect to the sale of new securities by companies, in addition to amounts required for refunding purposes, the funded and/or long term debts of oil companies have shown material expansion in the last two years, and in all probability are at the highest level in many years.

As of December 31st, 1938, the amount of such indebtedness of 18 firms included in the following tabulation was $855,549,194, whereas a year earlier 16 had outstanding only $628,150,432. With the new financing undertaken by several corporations this year, aside from refundings, it is evident that fixed indebtedness of the 18 companies now is slightly in excess of $900,000,000.

Largely because of new financing in 1938, the working capital of the 23 American oil companies in the following tabulation showed a substantial increase. It totaled $1,752,000,000 at the close of that year and compared with $1,555,000,000 a year earlier.

With all the 1938 income accounts for the American oil industry now at hand, it is revealed that profits for these 23 companies were 46 percent smaller than in 1937, and amounted to $324,717,742. The record was $607,423,900 established in 1937.

The only company to establish a record on profits in 1938 was Creole Petroleum Corp., the Venezuelan subsidiary of Standard Oil Co. (N. J.). Because of its overseas operations it is not included in the grouping of 23 American companies.

American producing companies last year came through with the best profit showings since their operations were affected only by restrictions on output and a 12 percent reduction in crude prices in October. The report by Barnsdall Oil Co., showing a 48 percent increase in profits, was not the result of operations but resulted because the 1937 profits were sharply reduced by certain nonrecurring adjustments in connection with property acquisitions and disposals.

Mid-Continent integrated companies suffered the most serious setbacks in profits since it was in that area during 1938 that price levels for gasoline were subnormally low. For these companies the reductions in profits ranged from 50 percent to 80 percent as compared with 1937.

In the accompanying tabulation is shown net income and per share earnings for 1938, together with working capital, funded and/or long term debts, and other pertinent financial data for 23 American companies and for two companies operating abroad, the Imperial Oil Co., Ltd., and Creole Petroleum Corp., both affiliated with Standard Oil Co. (N. J.), for five years ended December 31st, 1938.

Foreign Oil Legion

—Times Wide World

Sheik Mohammed bin Isa al Khalifah—brother of Sheik Hamid, ruler of the Bahrein Islands—who arrived in New York July 28th on board the Conte de Savoia as guest of Pearl Associates. Bahrein Petroleum Company, Ltd., is acting as unofficial host for the Sheik, and he was met at the pier by M. W. Thornburg, vice-president, and was escorted through the city by motorcycle police. Sheik Mohammed is senior counselor at his brother's court and successor to the throne.

—W. P. Staff

R. I. Dodson and F. Perez, executive representative and chief counsel for Andian National and Tropical Oil Corp. in Colombia, as they sailed from New York on the Santa Elena July 21st after a visit to the United States.

—Robert Yarnall Ritchie

J. L. Mathieu, of Schlumberger Well Surveying Corp., at the Pan American air base at Port Washington, N. Y., just before flying to France where he will spend the next four months. In his absence from Houston, P. Charrin, vice-president, will take over his duties.

—W. P. Staff

B. P. Newton, vice-president of Gulf Oil Corp., who sailed for Europe on board the Normandie, leaving New York August 2nd. Mr. Newton is in charge of the company's overseas activities and will be making calls at Paris, Antwerp and London.

—W. P. Staff

A. H. Blondel, representative of Société René Berg, sailed from New York to France July 22nd on the Ile de France after three months in the United States. Much of his time was spent in acquiring information at Waukesha on octane testing equipment.

—W. P. Staff

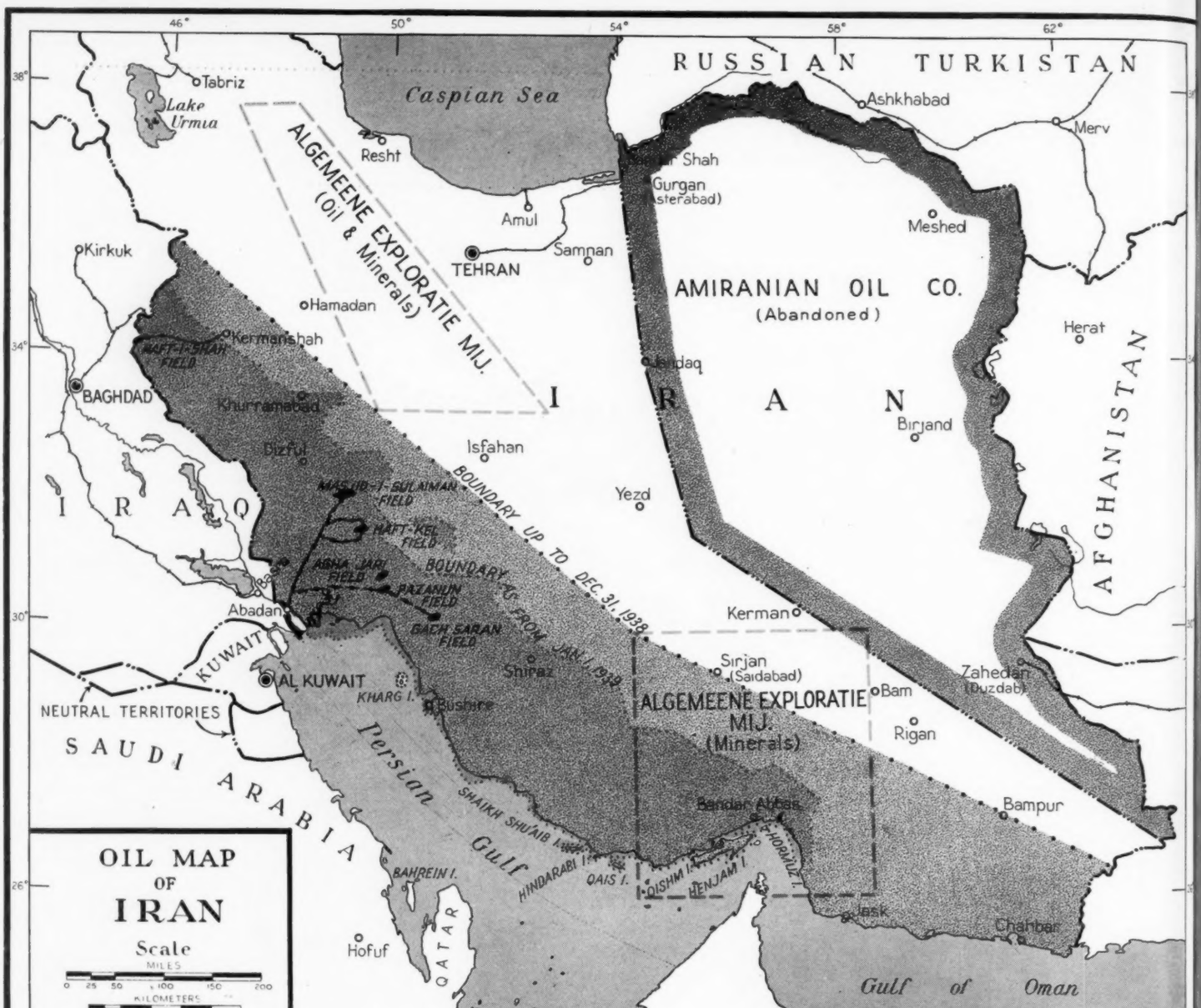
B. R. Cunningham (left) of Caribbean Petroleum Company talking to Bill Nutto of Reed Roller Company, shortly before they bade adieu to Val Wittoch, New York equipment export representative; they sailed on the Santa Rosa en route to Venezuela, July 28th.

—W. P. Staff

C. E. Patterson, who was recently appointed training supervisor with Standard Oil Company of Venezuela, at Caripito, was also on the Santa Rosa —Shown here with Clay Johnson of Schaffer Tool Works (right).

—W. P. Staff

W. E. Gray, district superintendent at Temblador for Standard Oil Company of Venezuela, with his wife and A. V. Simonson, New York export representative (right) just before sailing for Venezuela on the Santa Elena July 21st, after spending a vacation touring the United States and visiting friends and relatives in Louisiana, Texas, Oklahoma and California.



NOVEL TERMS

in New Iranian Oil Concession

CONSIDERABLE interest has resulted from the recent announcement of the terms under which the Iranian Government has granted two large concessionary areas in northern and southern Iran to Algemeene Exploratie Maatschappij. By taking the immediate loss of annual payments the government will become an indirect partner in the venture inasmuch as it will receive its reward by participating to the extent of 50 percent in any net profits eventually made. In return for half the possible revenue for exploitation of these concessions, the government has agreed to waive any rights to duty on either production or exports, and all the other complicated formuli of dead rent, import duty on equipment, etc. As it has everything to gain through success of the development the full and active support of the government may be expected by the concessionaire.

This is a radical departure in the attitude of any government toward oil companies seeking concessions. It will be interesting to follow this experiment as to whether it finds favor with other concerns which may seek rights over petroliferous areas in Iran. Successful discovery of petroleum in commercial quantities may cause other governments to turn toward this type of agreement and facilitate the negotiations of other oil companies.

The northern of the two concessions has been granted for the search of both oil and mineral deposits, while the southern area covers only minerals because of an appreciable overlapping of the territory of Anglo-Iranian in the vicinity of Qishm Island. The total area of the two concessions is about 236,000 sq. km. The northern concession overlaps neither the revised nor older area which has been under exploration by Anglo-Iranian, nor does it cover any part of the former concession of Amiranian Oil Company (Seaboard interests) which was abandoned about July 1st, 1938.

Iranian capital will be invited to participate

Government Establishes Precident in Agreement with Algemeene Exploratie Maatschappij —To Waive Initial Payments for Share in Eventual Profits—Anglo-Iranian Oil Company Cedes Half of 200,000 sq. mi. Concession.

in this development to the extent of 49 percent of the total, under the agreement, in the case of any public capital issue being made at any time. In any case, the bulk of the capital must remain in Iranian or Netherlands hands and the government has reserved the right to appoint a representative on the boards of the subsidiaries.

Separate subsidiary companies will be formed for the individual concessions and will be exempted from all import and export duties, and all present and future national, local and other taxes, with the exception of the four percent on net income. Currency restrictions will not be binding on the companies, nor will any restrictions be imposed on the imports of any materials necessary for the company's operations or for the export of petroleum.

The concessions are granted exclusively to the company for a three year period, but may be cancelled after one year or after the second year. Both oil and mineral exploration must commence within six months of ratification and a minimum of Fl. 500,000 ($250,000) has to be spent—Fl. 100,000 ($50,000) in the first year and Fl. 200,000 ($100,000) in each of the subsequent years. The company is free to proportion this expenditure between oil and minerals as it sees fit and, should the search be successful, exclusive exploitation rights will be granted for 60 years.

No systematic prospecting has been carried out in either the northern or southern areas for oils or minerals, although several minerals are known to exist in both. Oil search will be concentrated around the lower half of the northern concession at the start, to the west of the existing oilfields of Anglo-Iranian. Any petroleum discovered will, in the first instance, be marketed in Iran.

ANGLO-IRANIAN

Details are now available of the revised concession of Anglo-Iranian Oil Company, Ltd. Under the original terms, the company's concession covered some 500,000 sq. mi., but a number of years ago this was reduced to 200,000 sq. mi. with the proviso that a further 100,000 sq. mi. must be ceded to the government by the end of 1938. After detailed surveys during the past five years the company has picked out the area which it considers most favorable with regard to oil potentialities, and has given up a strip along the northern and eastern part of the concession of 1933-1938. It might be noted in passing that despite the lack of favorable results obtained in the wildcat well drilled at Qishm Island a decade ago, the company has retained that district within the revised concession. Possibly the discoveries made due west on the other side of the Persian Gulf have necessiated a revision of the structural geology of this region. It may also be noticed that the concession covers a number of other islands in the Gulf, and an appreciable strip in tide-water.

Abadan refinery is probably the largest in the world as a result of the steady expansion and modernization by Anglo-Iranian Oil Company, Ltd.

Black Star

U. K. EARNINGS

Contrast with Severe Reductions in U. S. A.

By Alec H. Day

ALTHOUGH British oil companies escaped the worst of the 1938 slump that left such a deep imprint on the earnings of American concerns, annual reports of the British undertakings now available, and statements of chairmen at annual meetings, emphasize the adverse effect on the oil industry of depressed general trade and disturbed European politics. But the relatively small extent of the decline presents a striking contrast with the severe reductions on 1938 earnings in the United States oil industry.

Results of British oil companies do not reflect conditions in any one country alone. Discovery of any two concerns operating in even approximately similar conditions would be extremely difficult. Nevertheless, nearly all the companies whose figures are analyzed below are concerned largely with selling for the British market or actually distributing in the United Kingdom.

	Profit 1938	Profit 1937	Increase or Decrease	
	£	£	£	Percent
Anglo-Iranian	6,109,477	7,455,094	−1,345,617	−18.0
Apex Trinidad*	239,814	260,935	−21,121	−8.1
Burmah	4,015,246	4,162,285	−147,039	−3.5
Lobitos	252,232	262,637	−10,405	−4.0
Shell Transport	6,630,590	6,616,489	+14,101	+0.2
Trinidad Leaseholds†	534,870	675,101	−140,231	−20.8

*Year to September 30.
†Year to June 30.

These results present a marked contrast with those of leading American oil companies, which reported profit declines in 1938 ranging from about 30 percent to over 60 percent.

Range of British profit losses is only from 3.5 percent in the case of Burmah to 20.8 per cent in the case of Trinidad Leaseholds, while the Shell Company, like the Royal Dutch, actually reported a small profit increase last year. Ignoring Shell's small increase, the average fall in earnings reported by the six individual companies is only slightly over 10 percent.

Differences of marketing conditions during the year in Britain and America supply an obvious reason for the divergence of company experience. The big American concerns are international in scope, but were directly affected, nevertheless, by the unfavorable course of events in their home market.

Production of crude in the United States was maintained at a high level, but even so was insufficient to meet the refinery demand. Refinery activity developed in spite of the unfavorable effect of trade depression on motor fuel consumption and the reduced offtake of fuel and lubricating oil as a result of reduced industrial activity.

Excessive refinery operations had a persistently depressing influence on selling prices, already predisposed to weakness by the falling off of demand, and finished by breaking the crude price structure. In the resulting conditions of disequilibrium, no oil company could be expected to maintain its profits at anything approaching the 1937 level. Oil results in 1938 were ruined by competition within the industry.

Both in turnover and prices, the United Kingdom market presented a happier picture, although the decline in the price of motor spirit in the British market was actually heavier than in the United States.

Lower Gulf prices for motor spirit and reduced tanker freights were reflected in a fall in the average selling price of No. 1 grade motor spirit of nearly 1d. per gallon. Excluding tax, the average was 10.2d. per gallon for 1938, compared with 11d. for 1937. Such a decline looks large against the fall from 14.58 cents to 14.07 cents shown by the American A. P. I. figure of service station prices in 50 cities.

British quotations for No. 1 spirit represent only a portion of the turnover of motor fuel. The great part of the business consists of commercial spirit, sold largely under contract at highly competitive prices. These prices follow roughly the course of the first grade price, but were probably not subject to the uneconomic competition which cut United States oil profits so severely.

Immunity from intense competition also applied to a good many other oil products, published prices for which showed little change on the year apart from a substantial reduction in lubricating oil quotations.

Taken as a whole, prices in Britain were relatively steady, and the effect of their steadiness was accentuated, as far as oil profits are concerned, by an expanding demand. Judged on the basis of customs releases of hydrocarbon oils, United Kingdom consumption of all products compared very favorably with the trend in America. Demand rose from 61,535,000 bbl. in 1937 to a new high record of 62,188,000 bbl.

The figures do not give a complete picture of consumption, since they exclude light coal and shale oils and power alcohol. But they show plainly enough that whereas United States demand for crude and all products, including exports, fell by about two percent, British consumption actually increased. The effect on the trend of oil profits in the two countries is important.

That British consumption should have shown a rising trend in the fact of a trade setback is doubtless due to the wider uses already attained by petroleum products in the United States, and the highly motorized state of that country. No one would suggest for a moment that America is anywhere near the saturation point in relation to petroleum consumption, but in view of the relative backwardness of the United Kingdom, the impulse towards expanding absorption of oil products is obviously greater there than in America. The gap to be filled in Britain by further motorization is larger, and the flow of new development to fill it is correspondingly stronger.

This aspect of British oil distribution is evident in the consumption figures. Improvement in the aggregate was more than accounted for by the rise in releases of motor spirit, which advanced by 2.3 percent to 38,526,000 bbl. Despite competition, motor spirit is one of the highest priced products, with consequent scope for profit making. If the percentage profit taken in Britain was infinitesimal, as it undoubtedly was in most cases, the companies derived some compensation for low 1938 prices by an increased turnover.

Resistance of British oil profits to the depression in the industry may therefore be attributed to a better volume of business, carried largely on invariable overheads, and the possession of a more compact market. The second factor is important, for with relatively few companies operating, and no production problem, the United Kingdom obviously presents better opportunities than the United States for keeping competition within bounds.

Last year's difference between British and American company results were largely due to the distance of the British market from the disturbing factors in the world oil industry emanating from the United States. Although the fall in American prices may have been due partly to circumstances outside the control of the industry, there is no doubt that developments in the United States, as the largest producing and consuming country, were the main cause of the universal weakness of petroleum prices. American oil companies

Increased Turn-Over Offsets Low Prices—Closer Relation Between British and American Results Possible in 1939—Confidence in Future Suggested By Policy of Long-Term Investment by Major Companies.

naturally felt the impact of oil depression more forcibly than countries further removed from the centre of disturbance.

In the case of some British undertakings, a certain time-lag between market changes and the effect of those changes on financial results is always possible. To the extent that this state prevails, the companies concerned may show in 1939 some part of the effects of 1938 depression.

That fact may affect the relative trend of British and American oil results during the current year. Although it is as yet too soon to make predictions in a world disturbed by many political and trade uncertainties, the current course of the industry suggests that the divergence of experience between oil companies in the two countries will be much less marked this year than it was in 1938.

Confidence in the oil industry's future is suggested by financial policies of British oil companies, as indicated by recently published statistics. Most of the leading concerns and many smaller but important undertakings have been investing money in oil assets in a manner not seen since the early days of the industry.

Reflected in their annual reports, this has meant a striking increase in fixed assets and a corresponding reduction in liquid resources. Some idea of the extent of this increase is shown by the accompanying table, which deals with the changes, from 1937 to 1938, of the fixed asset items of some of the large companies in Great Britain.

FIXED ASSET CHANGES

Company	1937	1938
Shell Transport	£36,281,805	£40,798,325
Anglo-Iranian	30,716,885	34,264,435
Canadian Eagle	8,356,229	10,258,782
Anglo-Egyptian	3,072,685	3,240,670

These capital expansions were made by means of funds obtained by cashing in liquid items held by the companies. Shell Transport, being a holding company, increased its investments in and advances to subsidiaries. Anglo-Iranian's rise may be attributed to its energetic development of the Gach Saran district and to augmentation of equipment at the Abadan refinery. Canadian Eagle's increase was a result both of additional investments in subsidiaries and of new exploration outlays as well as expenditures for new tankers and increased stocks of refined oils. Anglo-Egyptian made new developments at Ras Gharib and also invested in additional refinery facilities.

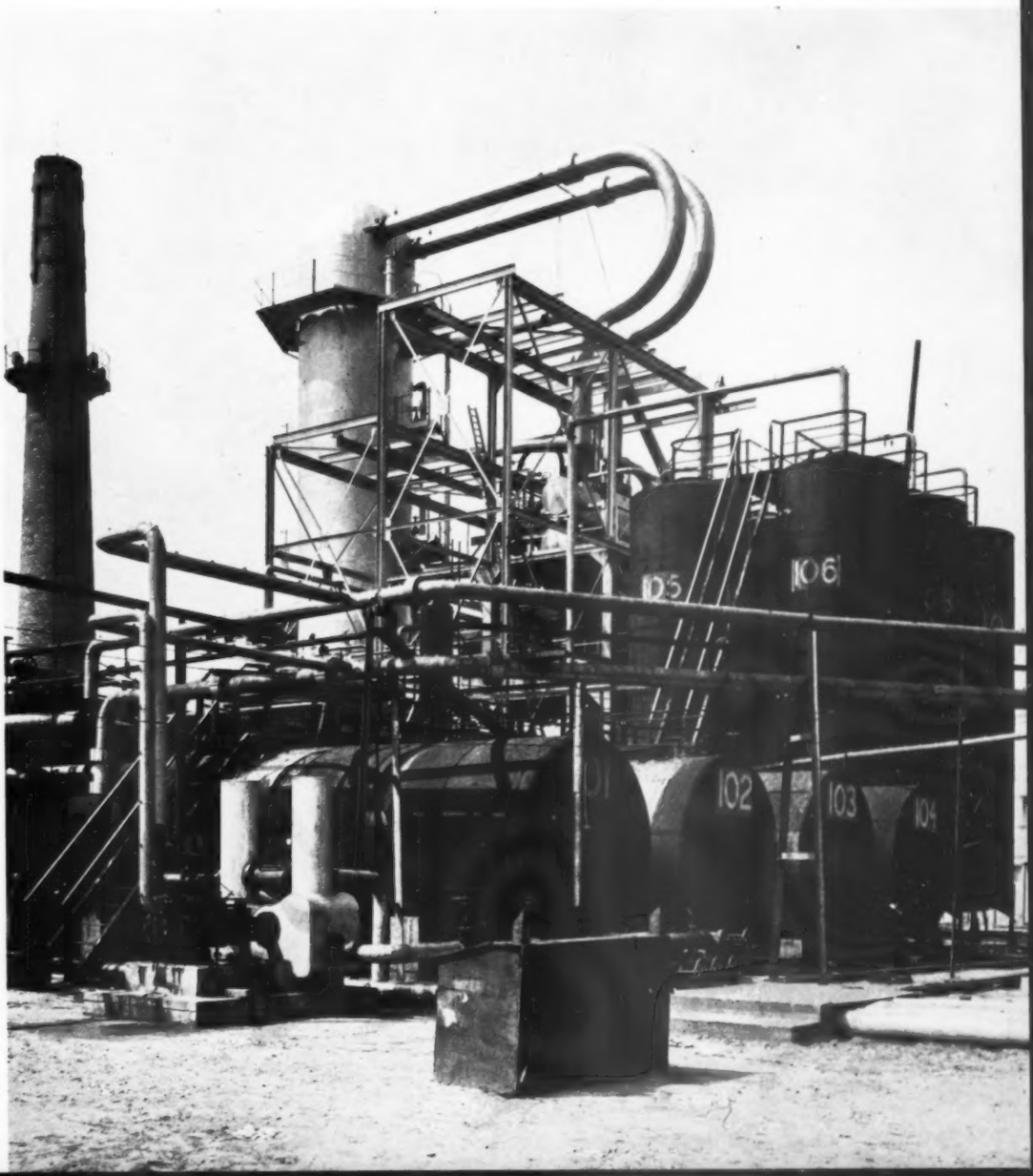
Several other companies obtained funds by new financing. Venezuelan Oil Concessions used part of the funds it obtained in this manner to repay temporary advances made by Anglo-Saxon and put the balance into its capital assets. Attock and United British Oilfields of Trinidad both obtained funds by new issues, and while most of the funds so acquired still are held in liquid form, they are earmarked to follow the small portion that already has been expended on capital resources.

Use of additional funds in fixed assets with a concomitant decrease in cash or its equivalent is thrown into relief by the strength of the impulse towards financial liquidity now pervading British financial and business life. Most business men have been refusing to invest and some sections have instituted a debtors strike by delaying payment of trade accounts in their desire to keep cash in hand. Oil companies, on the contrary, have been handing out cash to obtain assets, which, however valuable, are of an unrealizable character.

Any search for an explanation of this anomalous policy might consider the fact that the companies, with the exception of Attock, are connected, in one way or another, with the Royal Dutch-Shell group. The explanation presents itself, that this may reflect the long term policy of the Royal Dutch-Shell group.

Three explanations of the discrepancy between oil company and other business policies are possible. The fact that all these companies have embarked on an expansion of assets may be no more than fortuitous. It may reflect the view of the controlling group that the outlook for oil is so good that the development, and the consequent use of additional cash resources, is an advantageous move in long-term policy to build up future reserves. A third explanation would be that, despite the intense desire for liquidity that has been felt in other lines, the companies concerned have a greater faith in the possession of tangible assets than they have in any kind of currency.

General view of distillation plant, Manchester Refinery Ltd., England.



Continuous Regeneration Process Aids Removal of HYDROGEN SULPHIDE

By H. N. LaCroix and L. J. Coulthurst
Design Engineers—Foster Wheeler Corp.

Shell's Tri-Potassium Phosphate Treatment Operates at Comparatively Low Temperatures, Has No Corrosion Problems — Inexpensive Installation and Maintenance Costs

HYDROGEN SULPHIDE may be readily and cheaply removed from both liquid and gaseous hydrocarbons by a new regenerative process developed by Shell Development Company.* Removal of H_2S is of the utmost importance to refiners and chemical manufacturers, as well as to consumers of the finished products. With the development of new methods for marketing and utilizing the lighter components of crude oils, the removal of H_2S assumes even greater importance to the refiner.

Among the detrimental effects are loss of product, reduction in process efficiency, and high maintenance costs due to corrosion of equipment. These apply particularly when H_2S is present in charge stocks to polymerization plants, alkylation units, and in the production of iso-octane, hydrogen, aliphatic alcohols, various organic chemicals and liquefied propane and butane, also in natural gas, whether for domestic or industrial consumption. The H_2S forms mercaptans, organic sulphides, and other sulphur compounds with the hydrocarbons, or deleterious reaction products with some catalysts or treating agents, in addition to having unpleasant odor and poisonous influence upon the human system. Sulphur compounds in the final products are difficult and expensive to remove by after-treatment; consequently prior treatment of both liquids and gases is generally preferable. Even if the sulphur compounds are subsequently treated, the quality of the final product may be impaired by reducing the octane rating or blending value of motor fuel.

Hydrogen sulphide may be removed by a number of methods and caustic soda wash is the simplest and probably the oldest. This method is effective, but for every pound of H_2S removed, 1.2 lb. of caustic soda is used. The soda is irretrievably lost and the cost of operating the process is high. Shell Development Company's process is based on the intimate contact with aqueous solutions of a single compound, tri-potassium phosphate, which does not have these.

The tri-potassium phosphate method of H_2S removal acts in a manner similar to that of caustic soda, since the solution acts as an alkali to H_2S in absorbing it from its gas or liquid hydrocarbon carrier. The new process differs radically from the caustic soda method, in that, after absorbing the H_2S, the solution will readily reverse its characteristics and expel the H_2S when heated to the boiling point. This permits the absorbing chemical to be reactivated continuously, thus restoring it to its original form.

*U. S. patent numbers: 1,945,163; 2,110,403; and 2,157,879.

FUNDAMENTALS

The tri-potassium phosphate process for H_2S removal from hydrocarbon gases and liquids is a continuous regenerative process based on absorption of H_2S to form compound which may later be broken down by heating to a temperature slightly higher than the boiling point of water. Only cooling water and steam, or some other heating medium, are required for its operation beyond the initial charge of phosphate.

When treating large volumes of hydrocarbons having high H_2S content, it is possible to recover the sulphur economically, either by conversion into elemental sulphur or sulphuric acid, or as H_2S, essentially free of hydrocarbons or mercaptans.

The absorption reaction is reversible and may be expressed as follows:

$$H_2S \text{ plus } K_3PO_4 \rightleftarrows KSH \text{ plus } K_2HPO_4$$

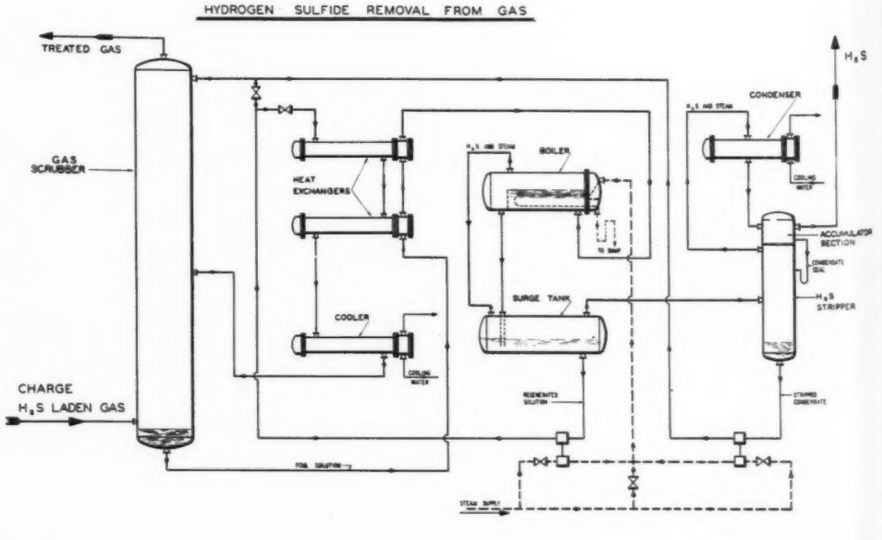
The direction of the reaction is controlled by temperature while the driving power of the reaction depends upon the ratio of tri-potassium phosphate to potassium acid sulphide.

The treating medium is a stable inorganic salt solution having a specific gravity varying between 1.2 and 1.5. Basic ingredients for its manufacture are common caustic potash and phosphoric acid, both of average commercial purity and readily available at reasonable cost. They are used at a ratio of approximately three mols of KOH per mol of H_3PO_4. The solution is easily made and handled, and is not poisonous, volatile, corrosive or inflammable.

The concentration of the treating solution for use in this process depends on the H_2S content of the liquid or gas to be treated, desired purity of the product after treatment, treating pressure and treating temperature.

REGENERATION SECTION

Foul solution from the base of the gas scrubber is conducted through a series of heat exchangers in which the desired preheat is obtained from the hot regenerated treating solution, and is then ready to be regenerated. Regeneration is accomplished simply and quickly by holding the solution at the boiling point a short time until the reversal of the absorption reaction has taken place. A simple kettle-type reboiler is all that is required for this purpose. The boiling takes place normally at temperatures in the vicinity of 225 to 240 deg. F., and, hence, exhaust steam from the pumps may be used as a source of heat. The chemical reaction is reversed and the solution restored to its original components, ready for recirculation. Hydrogen sulphide, saturated with steam, is evolved within the boiler, conducted to a surge tank, and ultimately piped into the hydrogen sulphide stripper. There remains a strong, regenerated solution of tri-potassium phosphate, concentrated in proportion to the amount of water boiled off.



At the rear of the boiler the regenerated treating solution spills over a weir into a sump from which it flows by gravity into the surge tank. The concentrated fresh treating solution is continuously withdrawn by means of a pump and most, or all of it is passed through heat exchangers where its heat is used to preheat the cooler spent solution. This results in economy of cooling water and heating steam. The regenerated solution may be further cooled, if necessary, to the desired treating temperature in a shell-and-tube cooler, employing water as a cooling medium, and is then introduced directly at the mid-section of the gas scrubber. A small portion of the hot regenerated solution from the surge tank is blended in a mixing valve with stripped condensate and introduced into the top section of the gas scrubber to maintain the desired concentration of weak tri-potassium phosphate solution.

In order to recover water for the dilute treating solution and to liberate H_2S from the unit in a relatively dry state, it is necessary to separate the hydrogen sulphide from the steam that was evolved with it in the boiler. Steam and hydrogen sulphide from the surge tank are introduced to a stripper column just below a series of bubble trays filled with partially stripped condensate. As the vapors rise through the trays, part of the steam is condensed and the H_2S separated from this condensing steam. On leaving the stripper, the vapors flow to a shell-and-tube, water-cooled condenser where the steam is condensed. The H_2S gas returns with the condensate to an accumulator section at the top of the stripper where a temperature of about 90 deg. F. is maintained. Here, the H_2S vapors are dried of nearly all of the water present, since the vapor pressure of water is less than 37 mm. of mercury at 90 deg. F. The H_2S is then readily vented from the system. The condensate is returned to the stripping section as reflux, flows downward over the bubble trays, and is denuded of any remaining H_2S. Stripped condensate is continuously removed from the bottom of the stripper and pumped to the top of the gas scrubber for blending with regenerated solution to form weak treating solution.

TREATING LIQUIDS

Hydrogen sulphide can be removed from liquids even more easily than from gases, due to the fact that at the same temperature and pressure, the distribution factor for H_2S is three times more favorable for treating liquids than for gases. Moreover, a more favorable contact is possible in the liquid phase with the aqueous tri-potassium phosphate solution.

TREATING SECTION

Aqueous solutions of tri-potassium phosphate and liquid hydrocarbons are immiscible and it is necessary to obtain intimate contact between them in a mixing device. Two stages of vertical contractors are used for this purpose. The liquid charge stock containing H_2S is joined by a partially spent treating solution and the two liquids are then thoroughly intermixed in the first stage contactor. From here they pass into a horizontal tank, identified as the first-stage phase separator, which operates full of liquid. Here, the heavier, foul treating solution is segregated as a lower layer. The upper layer of lighter, partially-treated liquid hydrocarbon leaves at the top of the tank and flows into the second-stage contactor, for treatment with fresh solution.

Freshly regenerated treating solution is introduced into the second contactor and the two liquids are again thoroughly intermixed just as in the first stage. They are then passed into the second phase separator where the tri-potassium phosphate solution again separates out as the bottom layer. At the top of the separator the treated liquid, from which essentially all H_2S has been removed is finally collected and withdrawn continuously from the system.

The freshly regenerated treating solution is introduced only at the inlet of the second contactor and after being used for the final treatment of the liquid, is separated out as partially-spent solution. Part of this solution may again be passed through the second-stage by means of the second-stage recycle pump, if desired. Where H_2S is to be removed from liquids having high concentrations, no recycle is usually necessary, since the volumetric ratio of phosphate to hydrocarbon is high enough to assure adequate contacting efficiency, but in many cases a certain amount of solution recirculation is advisable in each stage.

The remainder of the partially spent solution from the second-stage separator is delivered by the inter-stage transfer pump to the first-stage contactor where it is joined by the incoming liquid bearing the full charge of H_2S. After passing through the first-stage contactor, the treating solution is heavily charged with H_2S in the form of potassium acid sulphide. A portion of this foul solution may be recirculated by means of the first-stage recycle pump and the remainder is returned to the regeneration section for removal of H_2S.

Thus, only freshly regenerated tri-potassium phosphate solution is used for the final cleaning up of the liquid in the second-stage contactor, and the incoming liquid charge, laden with H_2S, is treated only with partially-spent solution. The foul solution is returned for regeneration only after passing through both of the contact stages.

REGENERATION SECTION

The regeneration section for the removal of H_2S from liquids is identical in general arrangement with the corresponding section for the treatment of gases. In locations where H_2S is to be removed from both gases and liquids, a single regeneration section may be used, with the result that the installation is simplified and the investment considerably reduced.

PLANTS OPERATING

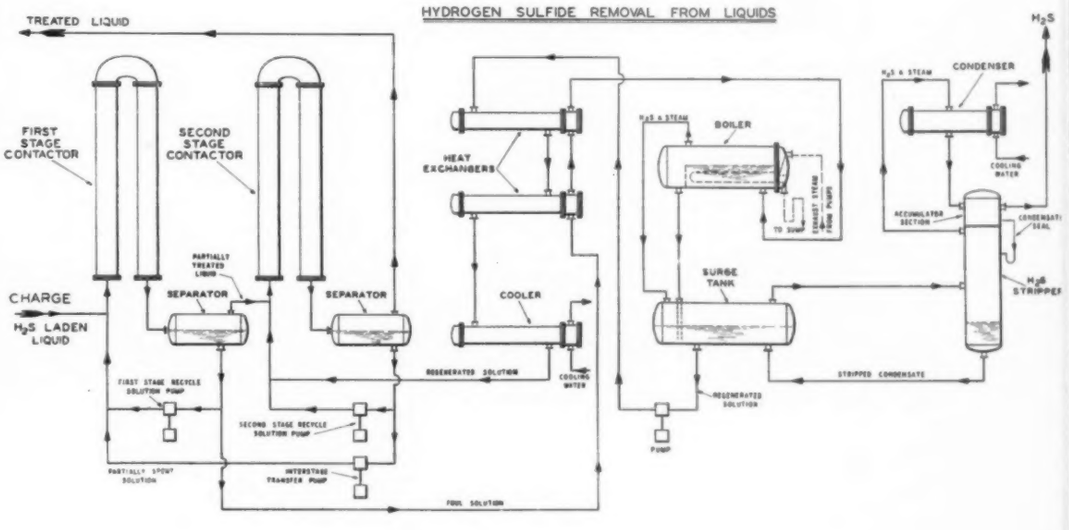
A number of plants are using the process to remove H_2S from hydrocarbon gases and liquids. There are five plants together charging hydrocarbon gas at a combined rate in excess of 35,000,000 cu. ft. per day. Individual units range in capacity from 2,000,000 to 13,000,000 cu. ft. daily. The gases charged range from low H_2S content to as high as 3,000 grains per 100 cu. ft., and the treated gases contain as low as 15 grains per 100 cu.ft.

The liquid phase process is now in commercial use in two plants for treating liquid propane and butane mixtures and may be applied to heavier hydrocarbons where the H_2S content warrants such treatment.

The H_2S gas that is separated out in these plants is burned as fuel or waste gas in most cases. In some instances it is used for the manufacture of sulphuric acid, as in one plant where the H_2S is separated at a pressure of approximately 15 lb. ga. with a purity of 99.3 percent, and is delivered at its own pressure through a pipeline, three-quarters mile long, to a neighboring chemical plant.

OPERATING COSTS

A limited amount of electricity is required for lighting and instruments, but this is negligible in comparison with the value of steam and water, as shown in Table I. Operating costs are low, due to the efficiency of the phosphate as a medium of absorption, to the high degree of heat exchange, and to the fact that experience has demonstrated that there is substantially no loss of the chemical used.



In this process live steam may generally be used for all of the pumping services within the unit. The exhaust steam from these pumps is used again as a source of heat for the boiling and regeneration of the foul phosphate solution. The total steam requirements are further reduced by using heat exchangers to preheat the spent solution on its way to the regeneration system; cooling water requirements are likewise reduced. Although the treating solution consists largely of water, the system is closed, and loss of water is negligible.

TABLE I

Example of water and steam requirements for 100 lb. has removal gases of various contaminations.

Based on: Treatment to final purity of 50 grains per 100 standard cubic feet.
Absorbing temperature—170 deg. F.
Pressure—200 lb. per sq. in. abs.
Equilibrium Solution Concentration—2.0 Molal K_3PO_4

Inlet Gas				
Grains H_2S per 100 s.c.f.	500	1000	2000	3000
Percent H_2S Removal	90	95	97.5	98.3
Lb. steam per 100 lb. H_2S Removed (Basis 50 lb./sq. in. ga. pressure)	1540	1010	860	780
Gal. Water per 100 lb. H_2S removed (Basis 20 deg. F. temperature rise)	7870	4920	4060	3600

Gases have been handled with H_2S content as high as 3,000 grains per 100 cu. ft. and the gases after treatment contained as little as 15 grains per 100 cu. ft. Even lower H_2S content may be obtained if desired. Treatment may be at whatever pressure the gas or liquid is flowing. The use of tri-potassium phosphate permits treatment of gases at temperatures up to 200 deg. F.—an appreciable advantage in preparing gases for polymerization.

A concentrated treating solution will retain more hydrogen sulphide per unit of volume than a dilute solution, but a dilute solution is capable of a more complete stripping from the fluid treated since it has a greater affinity for the H_2S. This characteristic is utilized to complete the stripping of the hydrocarbon gas just before it leaves the unit by contact with dilute treating solution after an initial contact with stronger solution. These solutions of K_3PO_4 normally range in concentration from 1.0 to 2.0 molal.

To illustrate the great affinity and capacity of tri-potassium phosphate treating solution for H_2S, a 31.8 percent by weight phosphate solution (about 1.5 molal) will contain over 3,000 times as much H_2S as a mixture of liquid propane and butane in equilibrium with it, and after treatment, the propane-butane product at equilibrium contains only about 0.0006 percent by weight of H_2S.

Hydrogen sulphide may be satisfactorily removed from gases with tri-potassium phosphate over a wide temperature range up to 200 deg. F. Furthermore, the treating medium has a negligible solution effect for hydrocarbons, since an aqueous inorganic salt solution is used. These characteristics of the process present distinct advantages in that entrainment of liquefied hydrocarbons with the treating solution may be prevented, and gas cooling requirements prior to treating may be reduced and possibly eliminated.

Control of the process is simple and plant operations may be made fully automatic, depending only on occasional specific gravity determinations of the phosphate solution, and Tutweiler or Orsat determinations of H_2S in the outgoing product to obtain the desired control settings. Since it is only necessary to maintain the specific gravity of the phosphate solution, the operation of the process is independent of any special component ratios, acid-alkali balance or hydrogen ion concentration. There are no volatile components to pollute the purified gas or liquid products, and no deleterious side reactions take place.

Experience in plant operation has shown that there are no equipment corrosion problems. The materials of construction, therefore, are simple and inexpensive; cast iron and low carbon steel are used throughout and no special alloys are necessary. Standard heat exchanger and condenser practice is followed and either reciprocating or centrifugal pumps may be used.

TREATING GASES

Gases bearing H_2S are exposed to intimate contact in a scrubber tower, first with a strong tri-potassium phosphate solution and then with a weak solution, in order to produce a treated gas that is relatively free of H_2S. After absorbing H_2S, the foul solution is regenerated by boiling, which reverses the chemical reaction, dispels the H_2S, and restores the treating solution for recirculation. The heating evolves H_2S vapor and evaporates water. These combined vapors are then separated in a stripper; H_2S is vented at the top and water collected at the bottom. The water is returned to the top of the scrubber to be used again in making up the weak treating solution.

TREATING SECTION

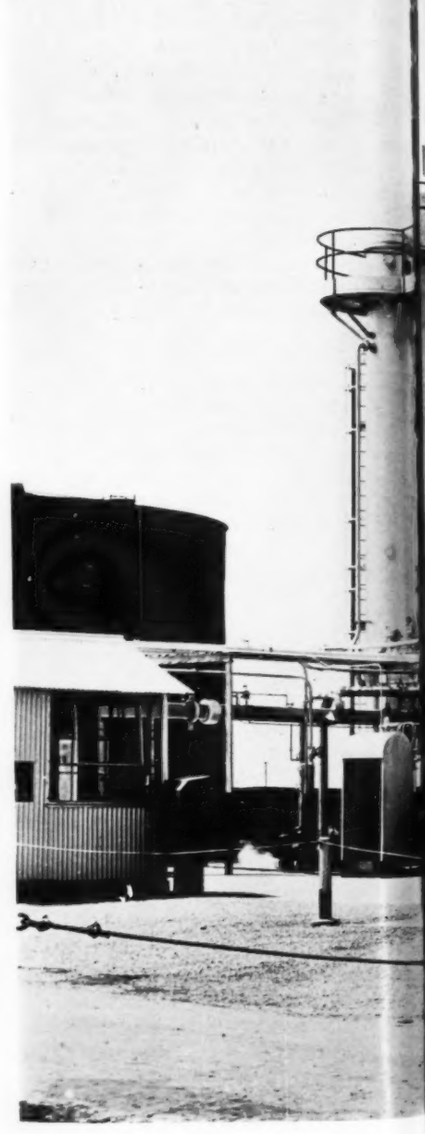
In detail, gaseous charge stock containing H_2S enters near the bottom of a scrubber, filled either with a system of bubble trays or with tower packing. As the gases rise, they receive a series of contacts with aqueous, tri-potassium phosphate solutions of two strengths; first, with a strong concentration having high capacity for H_2S, in the lower half of the tower, and then with a dilute solution, having affinity for H_2S, in the upper portion of the tower. In this manner, the H_2S content of the treated gas is reduced to a minimum before it leaves at the top of the scrubber, substantially free of H_2S and ready for any further processing.

The weak tri-potassium phosphate solution, introduced at the top of the scrubber, flows downward through the upper half of the tower, countercurrent to the gas under treatment. Stronger solution, which is introduced near the middle of the tower, joins the weak solution, and the combined streams flow downward, absorbing H_2S at a rapid rate. A reservoir for foul solution is located in the base of the scrubber. All of the H_2S extracted from the gas is contained in the foul solution, in the form of potassium acid sulphide, and the solution flows continuously to the regeneration section, generally under absorber pressure.

Process handling losses may be neglected because the slight leakage of phosphate at stuffing boxes of pumps is readily collected and returned to the system. Heat for regenerating the spent solution may be furnished by a direct-fire boiler or by any other heating medium, and the pumps may be motor-driven if desired.

APPLICATIONS

The tri-potassium phosphate process may be applied to treatment of hydrocarbon and other gases to recover a treated gas with H_2S content as low as five to ten grains per 100 cu. ft.; treatment of hydrocarbon liquids charged to polymerization or alkylation units



where H_2S is deleterious to the process; treatment of gasoline prior to mercaptan removal; and recovery of H_2S in concentrated form from gases and liquids for chemical use.

The phosphate process for H_2S removal has been thoroughly proven both in efficiency and economy by experience gained from a number of commercial units in operation. It operates at minimum cost because it is completely regenerative, the utility requirements are low, and substantially no replacement of chemical is required. The process is a practical means for removal of H_2S from gases and permits operation at temperatures up to 200 deg. F. For this reason, as well as the fact that the treating medium is an inorganic salt solution, condensation and absorption of valuable hydrocarbons is negligible.

The phosphate process requires only ordinary materials of construction, special alloys are not necessary, and plant cost is low.

TABLE II

CONVERSION FACTORS

Grains per Hundred Standard cu. ft. vs. lb. per Million Standard. cu. ft.

Grains/100 s.c.f.	100	200	300	400	500	600	700	800	900
Pounds/million s.c.f.	143	286	429	571	714	857	1000	1143	1286

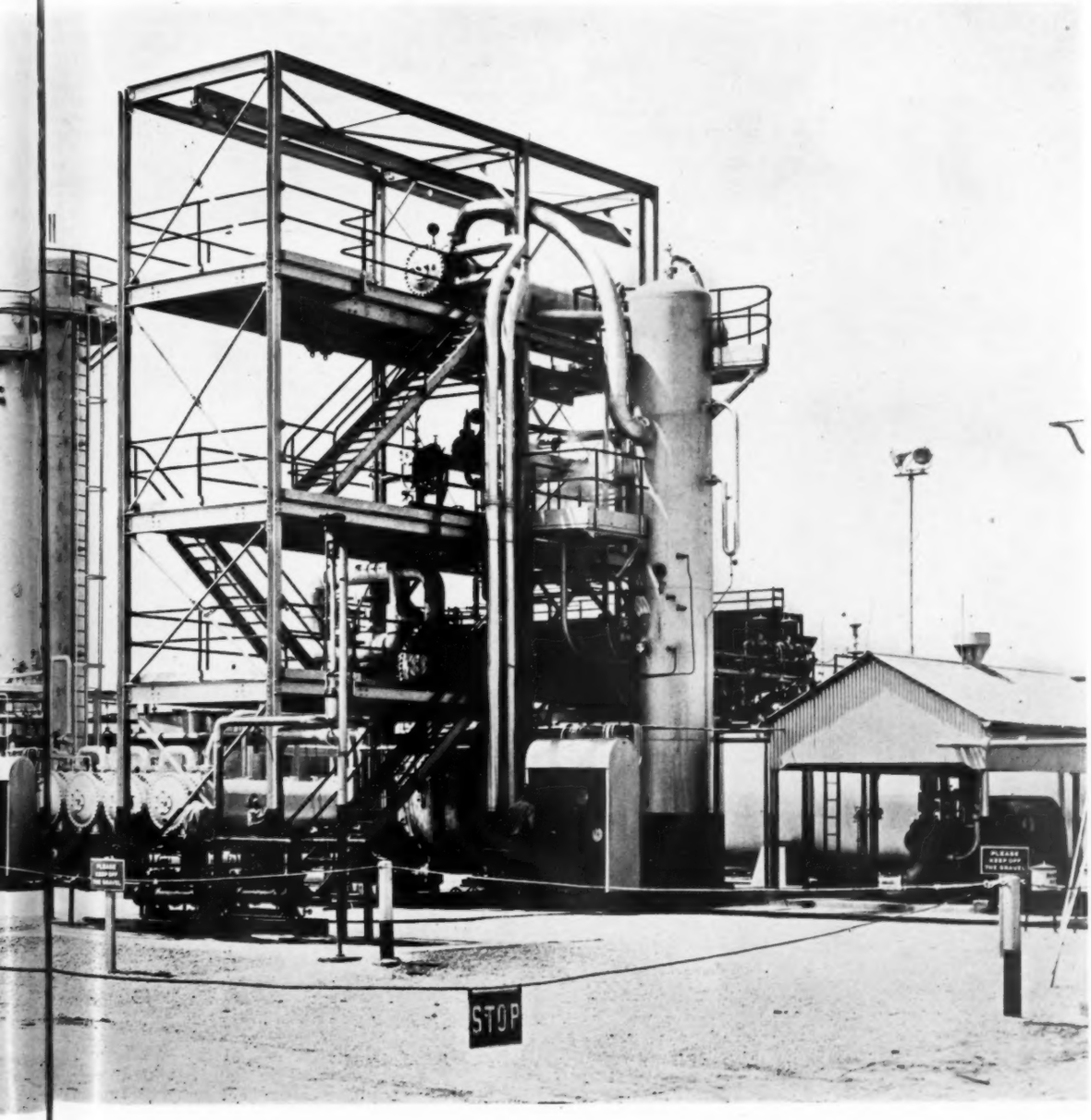
Volume percent corresponding to grains per 100 standard cubic feet.

In increments of 100 grains per 100 std. cubic feet.		In increments of 10 grains per 100 standard cubic feet.									
Grains	Percent	10	20	30	40	50	60	70	80	90	100
		.016	.031	.047	.063	.079	.094	.110	.126	.141	.157
100	.157	.173	.189	.204	.220	.236	.252	.267	.283	.299	.314
200	.314	.330	.346	.362	.377	.393	.409	.425	.440	.456	.472
300	.472	.487	.503	.519	.535	.550	.566	.582	.597	.613	.629
400	.629	.645	.660	.676	.692	.708	.723	.739	.755	.770	.786
500	.786	.802	.818	.833	.849	.865	.881	.896	.912	.928	.943
600	.943	.959	.975	.991	1.006	1.022	1.038	1.053	1.069	1.085	1.101
700	1.101	1.116	1.132	1.148	1.164	1.179	1.195	1.211	1.226	1.242	1.258
800	1.258	1.274	1.289	1.305	1.321	1.336	1.352	1.368	1.384	1.399	1.415
900	1.415	1.431	1.447	1.462	1.478	1.494	1.509	1.525	1.541	1.556	

*636 Grains per 100 cu. ft. equals one percent.

NOTE: Standard cubic foot measured at 60 deg. F. and 760 mm. absolute pressure.

Courtesy Shell Development Company



General view of large tripotassium phosphate unit for simultaneous treatment of two refinery gases of different compositions, having a single regeneration section. The combined capacity of the two absorbers is 13,000,000 standard cubic feet per day and the H_2S is marketed for sulphuric acid manufacture. From left to right are the two absorbers, cooler and heat exchangers, surge tank, reboiler, condenser and stripper.

WORLD OIL

All figures furnished direct to WORLD PETROLEUM by governments, except where otherwise specified.

U. S. BARRELS

	July 1938	Aug. 1938	Sept. 1938	Oct. 1938	Nov. 1938	Dec. 1938	Jan. 1939	Feb. 1939	Mar. 1939	Apr. 1939	May 1939	Preliminary Figures June 1939
United States	102,898,000	106,165,000	98,661,000	101,830,000	98,567,000	102,287,000	102,490,000	93,475,000	106,768,000	105,510,000	110,541,000	103,400,000
Soviet Union[4]	18,200,000	17,600,000	17,500,000	17,400,000	17,250,000	17,050,000	17,000,000	17,500,000	18,000,000	18,100,000	18,500,000	18,700,000
Venezuela	14,912,555	16,616,673	16,271,096	17,352,171	16,356,204	16,744,163	16,489,347	14,899,459	15,646,415	16,980,646	17,676,580	17,000,000
Iran[5]	5,338,990	5,861,366	5,676,998	7,136,578	7,221,080	6,624,726	6,408,776	4,982,000	6,999,058	7,244,370	7,000,000[1]	6,900,000
Netherland India: Sumatra	2,814,237	2,901,321	2,917,167	3,049,196	3,015,432	3,177,589	3,129,007	2,969,950	3,393,286	3,400,503	3,602,543	3,450,000
Borneo	1,061,980	970,690	1,069,872	1,123,102	1,090,009	1,114,535	1,115,570	1,000,937	1,134,647	1,123,474	1,173,509	1,137,000
Java[9]	585,086	524,384	482,417	523,623	515,160	529,658	535,297	503,441	550,097	509,355	530,273	535,000
Ceram	54,035	54,825	50,355	50,444	45,750	45,773	49,200	55,219	67,442	82,914	89,975	70,000
Roumania	4,115,000	4,075,736	3,915,029	4,028,750	3,847,324	3,969,300	3,934,338	3,638,020	3,973,053	3,759,111	3,839,580	3,760,000
Mexico[13]	2,864,277	3,247,904	3,416,583	3,313,182	3,698,725	3,245,558	2,470,000[1]	1,960,000[1]	3,118,021	3,140,120	2,945,000[1]	3,100,000
Iraq	2,806,903	2,829,528	2,621,547	2,431,949	2,420,143	2,290,777	2,414,878	1,955,122	2,699,272	2,608,216	2,663,827	2,620,000
Colombia	1,826,848	1,870,013	1,797,158	1,891,825	1,863,838	1,908,879	1,710,565	1,633,621	1,818,765	1,826,928	1,710,000[1]	1,724,000
Trinidad	1,500,171	1,505,959	1,514,893	1,594,480	1,503,489	1,664,322	1,652,412	1,499,197	1,630,789	1,569,298	1,645,040	1,640,000
Argentina[1]	1,349,000	1,360,000	1,358,000	1,360,000	1,358,000	2,028,000	1,534,000	1,430,000	1,556,000	1,549,000	1,556,000	1,530,000
Peru[2]	1,335,623	1,328,143	1,280,691	1,331,111	1,303,990	1,321,883	1,251,162	1,103,878	1,210,288	1,151,193	1,078,426	1,100,000
Bahrein[6]	699,176	713,149	714,349	708,962	613,281	623,907	647,988	610,766	658,822	629,336	626,009	650,000
Burma[7]	654,108	637,880	623,630	604,885	591,029	651,495	650,000[1]	500,000[1]	640,000[1]	635,000[1]	640,000[1]	635,000
Canada[7]	693,332	817,706	886,111	685,088	445,514	489,303	531,564	356,218	384,461	558,779	713,450	700,000
Brunei[9]	453,393	448,219	478,080	477,459	484,207	510,500	506,467	453,571	492,374	466,328	486,815	465,000
Great Germany: Old Reich[16]	346,435	342,484	328,098	331,792	307,433	313,206	332,592	330,584	395,181	373,126	409,782	380,000
Ostmark[15]	31,062	29,453	26,772	43,697	29,000[1]	34,259	33,609	46,666	43,293	54,375	64,840	55,000
Slovakia and Moravia	9,333	11,015	10,933	13,747	10,502	9,879	10,546	9,000[1]	10,000[1]	9,500[1]	10,000[1]	9,500
Poland	314,000[1]	328,115	321,134	330,412	318,000[1]	316,702	325,293	298,259	333,618	318,000[1]	330,000[1]	318,000
Japan[10]	216,707	217,525	170,597	220,451	224,255	173,737	224,885	218,594	222,368	218,594	221,229	221,500
British India[11]	241,191	225,897	217,058	210,348	197,809	217,528	195,000[1]	132,000[1]	230,000[1]	215,000[1]	230,000[1]	215,000
Ecuador	192,360	193,634	189,037	192,702	185,669	192,882	195,556	171,634	181,938	175,896	193,753	113,710
Saudi Arabia	3,550	3,459	40,556	136,947	152,632	139,038	155,605	170,865	215,270	234,742	281,325	392,932
Sarawak[12]	132,007	107,102	123,476	223,165	115,952	118,512	116,030	105,714	115,980	110,982	112,572	101,000
Egypt[13]	83,412	143,978	157,533	208,377	211,841	221,156	308,946	301,102	330,445	328,376	369,972	356,000
Italian Empire: Albania[16]	46,049	4,998	68,655	Nil	Nil	6,220	99,206	67,914	125,440	244,576	89,000[1]	83,000
Italy	9,378	9,057	8,267	8,622	8,533	7,937	7,511	8,090	8,324	7,797	8,200[1]	7,700
France	43,574	43,000[1]	41,104	42,296	40,797	48,000[1]	42,000[1]	40,000[1]	42,000[1]	41,000[1]	42,000[1]	41,000
Hungary	25,888	30,900[1]	38,240	49,800[1]	43,303	47,671	49,199	49,578	67,261	67,000[1]	70,000[1]	67,000
Bolivia[1]	9,500	9,200	8,500	8,800	8,500	9,000	8,800	7,000	8,700	8,500	8,700	8,500
Other Countries[17]	6,000	6,000	50,000	48,000	50,000	48,000	50,000	35,000	50,000	48,000	50,000	48,000
WORLD TOTAL	165,873,160	171,234,333	163,034,936	168,952,001	163,494,401	168,191,035	166,675,349	152,518,399	173,120,608	173,300,035	179,509,400	171,533,842

[1] Estimated.
[2] Includes natural gasoline naphtha production.
[3] International Petroleum Company and Lobitos Oilfields, Ltd., figures combined.
[4] Russian Saghalin included with U.S.S.R.
[5] Anglo-Iranian Oil Company, Ltd., figures revised —fuel oil returned to the ground has been deducted.
[6] Bahrein Petroleum Company, Ltd., figures.
[7] Does not include Assam or Punjab, which are listed together under British India.
[8] British Malayan Petroleum Company, Ltd., figures.
[9] Includes Madura.

Comparative Cumulative Daily Averages in Barrels

	Jan.-June 1939	1938
United States	3,437,481	3,330,807
Soviet Union	595,580	559,072
Venezuela	545,262	498,156
Iran	218,421	223,559
Netherland India: Sumatra	110,195	93,094
Borneo	36,934	35,261
Java	17,478	21,010
Ceram	2,291	1,696
Roumania	126,542	134,291
Mexico	92,448	106,738
Iraq	82,659	84,823
Colombia	57,591	57,586
Trinidad	53,242	46,646
Argentina	50,580	44,884
Peru	38,094	38,712
Bahrein	21,120	23,901
Burma	20,442	20,603
Canada	17,925	16,129
Brunei	15,860	14,007
Great Germany: Old Reich	12,272	10,390
Ostmark	1,645	971
Slovakia and Moravia	324	362
Poland	10,625	10,471
Japan	7,333	6,011
British India	6,724	6,159
Ecuador	6,146	6,138
Saudi Arabia	7,518	105
Sarawak	3,714	4,446
Egypt	11,021	2,955
Italian Empire: Albania	3,918	1,545
Italy	263	299
France	1,370	1,440
Hungary	2,044	545
Bolivia	278	293
Other Countries	1,553	193
WORLD TOTAL	5,616,893	5,403,298

Official Crude Oil Production Figures for 1932 to 1938 (Revised) in Barrels

	1938	1937	1936	1935	1934	1933	1932
United States	1,213,254,000	1,279,160,000	1,098,516,000	996,596,000	908,065,000	905,656,000	785,159,000
Soviet Union	206,192,000	201,856,661‡	199,635,921	184,008,033	175,635,783	155,596,429	155,927,907
Venezuela	173,506,497	187,675,477	155,270,840	148,809,057	136,098,681	117,113,940	115,615,782
Iran	78,320,840	78,109,001	62,977,950	57,520,488	57,902,092	54,440,075	49,516,697
Netherland India: Sumatra	34,538,128	33,451,511	30,469,428	28,004,595	26,336,011	22,345,172	18,570,923
Borneo	12,812,383	12,960,072	13,068,910	13,529,185	14,335,543	15,003,175	15,228,615
Java	6,955,283	7,152,931	3,618,293	3,462,440	3,778,920	3,600,816	3,837,142
Ceram	607,622	537,436	375,823	311,872	273,698	285,335	309,957
Roumania	48,366,000	52,395,725	63,532,846	61,270,072	61,849,306	53,919,708	53,651,973
Mexico	38,505,824	46,455,687‡	41,027,915	40,240,563	38,171,946	34,000,830	32,805,496
Iraq	32,404,000	30,603,660‡	29,913,150	27,410,983	7,639,849	1,094,915	87,840
Colombia	21,581,588	20,297,543‡	18,756,110	17,597,655	17,337,900	13,156,126	16,415,214
Trinidad	17,736,176	15,502,989	13,237,030	11,671,224	10,894,363	9,561,353	10,126,121
Argentina	17,076,223	16,354,717	15,457,960	14,297,025	14,021,901	13,690,556	13,138,747
Peru	15,908,279	17,459,112	17,593,069	17,056,555	16,314,381	13,257,318	9,899,263
Bahrein	8,297,998	7,762,264	4,644,635	1,264,807	285,072	31,377	900
Burma	7,499,498	7,847,553	7,587,718	7,181,113	7,278,859	7,114,311	7,073,437
Canada	6,936,479	2,995,025	1,507,931	1,447,204	1,410,895	1,145,333	1,044,412
Brunei	5,387,214	4,397,038	3,296,938	3,302,905	2,705,350	2,035,656	1,200,029
Great Germany: Old Reich	3,850,044	3,148,300	3,076,858	2,967,438	2,204,402	1,656,602	1,594,807
Ostmark	370,038	221,266	50,092	44,347	27,965	5,765	864
Slovakia and Moravia	130,867	122,790	126,603	136,580	177,797	121,695	126,660
Poland	3,828,438	3,799,862	3,869,575	3,901,881	4,011,336	4,174,079	4,219,634
Japan	2,511,184	2,487,841	2,403,072	2,294,878	1,872,837	1,504,412	1,683,439
British India	2,330,209	2,161,653	1,978,329	2,037,810	1,921,863	1,628,803	1,743,870
Ecuador	2,257,278	2,161,436	1,942,467	1,731,785	1,636,619	1,619,902	1,597,641
Saudi Arabia	495,135	64,968	19,777	Nil	Nil	Nil	Nil
Sarawak	1,624,882	1,655,565	1,547,882	1,776,593	1,942,591	2,206,815	2,329,733
Egypt	1,561,231	1,163,267	1,262,666	1,255,151	1,527,252	1,653,535	1,071,976
Italian Empire: Albania	437,597	380,292	219,693	41,218	17,500	11,437	9,212
Italy	106,083	112,700	129,653	128,615	162,449	213,534	242,563
France	516,240	507,067	534,063	529,664	700,000	786,366	755,146
Hungary	330,829	13,910	100	Nil	Nil	Nil	Nil
Bolivia	106,620	123,123	104,746	163,295	157,875	111,973	41,967
Other Countries	243,000	70,000	37,100	32,300	64,000	54,100	73,300
WORLD TOTAL	1,966,585,707	2,041,168,442	1,797,891,143	1,652,023,331	1,516,760,036	1,438,797,443	1,305,574,242

‡ Preliminary

PRODUCTION

Figures in U. S. barrels of 42 gal.—Conversion ratios used are weighted averages for individual countries

METRIC TONS

	July 1938	Aug. 1938	Sept. 1938	Oct. 1938	Nov. 1938	Dec. 1938	Jan. 1939	Feb. 1939	Mar. 1939	Apr. 1939	May 1939	Preliminary Figures June 1939
United States	13,939,606	14,507,243	13,189,481	13,785,028	13,343,306	13,846,893	13,874,374	12,653,243	14,445,677	14,275,470	14,956,000	13,900,000
Soviet Union[4]	2,497,000	2,414,000	2,401,000	2,387,000	2,366,000	2,339,000	2,332,000	2,400,000	2,469,000	2,480,000	2,536,000	2,590,000
Venezuela	2,205,195	2,455,545	2,404,477	2,564,234	2,417,054	2,474,385	2,438,207	2,201,782	2,323,150	2,521,254	2,624,585	2,525,000
Iran[5]	706,120	775,208	750,824	943,864	955,040	876,168	849,376	660,490	927,608	960,120	920,000[1]	918,000
Netherland India: Sumatra	377,750	389,439	391,566	409,288	404,756	426,522	420,001	398,651	434,424	435,476	461,214	442,500
Borneo	142,549	130,294	143,607	150,752	146,310	149,602	149,741	134,354	146,543	142,552	150,238	144,000
Java[9]	78,535	70,387	64,754	70,285	69,149	71,095	71,852	67,576	70,426	65,210	67,888	71,000
Ceram	7,253	7,359	6,759	6,771	6,141	6,144	6,604	7,412	8,634	10,615	11,519	9,000
Roumania	561,775	556,415	534,475	550,000	525,232	541,884	537,111	496,658	538,719	509,710	520,621	510,000
Mexico[13]	425,219	482,171	507,212	491,862	460,025	481,823	367,000[1]	291,000[1]	457,859	461,104	432,000[1]	455,000
Iraq	376,415	379,395	351,508	326,086	324,503	312,734	323,797	262,151	360,817	348,648	356,079	351,000
Colombia	254,669	260,629	250,475	263,669	259,768	266,046	238,406	229,371	253,663	254,802	238,000[1]	240,000
Trinidad	211,113	211,928	213,185	224,385	211,580	234,214	232,537	210,413	229,306	220,717	231,370	231,000
Argentina[1]	192,200	193,800	193,500	194,000	193,500	288,930	218,000	202,000	221,000	220,000	221,000	217,500
Peru[7]	168,725	176,006	167,718	177,893	172,805	175,667	166,281	146,286	159,774	151,973	142,367	146,000
Bahrein[6]	95,428	97,279	97,479	96,660	83,585	85,009	88,264	83,180	89,811	85,920	85,353	88,700
Burma[7]	90,309	88,068	86,101	83,548	81,634	89,985	89,100[1]	70,000[1]	90,000[1]	87,800[1]	90,000[1]	87,800
Canada[2]	87,586	103,298	111,686	86,545	56,280	61,812	67,151	45,000	57,640	71,109	90,793	88,500
Brunei[3]	59,464	58,772	62,688	62,607	63,491	66,939	66,410	59,474	65,749	62,271	65,007	62,000
Great Germany: Old Reich[14]	49,897	45,007	47,256	47,788	45,865	45,111	47,562	47,614	56,654	53,357	58,265	54,400
Ostmark[15]	4,634	4,394	3,994	6,519	5,600[1]	5,111	5,014	6,962	6,454	8,106	9,666	8,200
Slovakia and Moravia	1,521	1,609	1,597	2,008	1,534	1,443	1,545	1,500[1]	1,500[1]	1,465[1]	1,500[1]	1,465
Poland	41,000[1]	43,287	42,366	43,590	42,000[1]	42,688	43,819	40,202	44,968	41,000[1]	44,000[1]	41,000
Japan[10]	30,839	30,955	24,277	31,376	31,913	24,724	32,003	31,094	31,631	31,095	31,469	31,500
British India[11]	33,300	31,174	29,968	29,054	27,322	30,045	27,000[1]	18,000[1]	33,000[1]	30,000[1]	33,000[1]	30,000
Ecuador	27,262	27,412	26,791	27,310	26,314	27,336	27,715	24,325	23,986	23,190	25,544	25,539
Saudi Arabia	460	453	5,498	18,570	20,697	18,590	21,100	23,169	29,190	31,821	38,148	41,078
Sarawak[12]	17,309	13,913	16,191	16,150	15,204	15,540	15,214	13,862	15,838	14,197	14,401	14,200
Egypt[13]	11,924	20,583	22,521	29,789	30,285	31,617	44,390	43,045	47,193	46,897	52,838	51,000
Italian Empire: Albania[16]	6,873	746	10,247	Nil	Nil	41,674	14,869	10,179	18,801	36,657	13,000[1]	12,000
Italy	1,164	1,125	1,027	1,071	1,060	986	933	1,005	1,034	968	1,000[1]	960
France	6,102	6,000[1]	5,756	5,923	5,713	6,000[1]	5,900[1]	5,500[1]	6,000[1]	5,700[1]	6,000[1]	5,700
Hungary	3,349	4,000[1]	4,947	6,400[1]	5,602	6,167	6,619	6,670	9,049	9,000[1]	9,500[1]	9,000
Bolivia[1]	1,200	1,160	1,000	1,100	1,000	1,130	1,100	900	1,000	1,000	1,000[1]	1,000
Other Countries[17]	850	850	7,000	6,700	7,000	6,700	7,000	6,000	7,000	6,700	7,000[1]	6,700
WORLD TOTAL	22,714,595	23,589,804	22,178,931	23,353,817	22,407,268	23,099,714	22,837,995	20,898,978	23,683,098	23,705,904	24,546,305	23,410,242

[9] Japanese Saghalin, Taiwan (Formosa) and Hokkaido included with Japan.
[11] Excluding Burma.
[12] Sarawak Oilfields, Ltd., figures.
[13] Anglo-Egyptian Oilfields, Ltd., figures.
[14] Prussia, Thuringia and Baden.
[15] Formerly known as Austria.
[16] Italian imports of Albanian crude oil.
[17] Estimate representing Morocco, Cuba, New Zealand, Barbados, Greece, Algeria, Yugoslavia, Australia, Great Britain, Kuweit and China.
[10] Official Figures—Petroleos Mexicanos.

Comparative Cumulative Daily Averages in Metric Tons

	Jan.-June 1939	1938
United States	464,667	445,399
Soviet Union	81,807	79,862
Venezuela	80,851	73,615
Iran	28,925	29,567
Netherland India: Sumatra	14,319	12,504
Borneo	4,792	4,733
Java	2,287	2,819
Ceram	297	228
Roumania	17,198	18,330
Mexico	13,613	15,846
Iraq	11,064	10,982
Colombia	8,034	8,419
Trinidad	7,488	6,572
Argentina	7,180	6,403
Peru	5,042	5,862
Bahrein	2,880	3,177
Burma	2,844	2,873
Canada	2,322	2,038
Brunei	2,104	1,841
Great Germany: Old Reich	1,756	1,498
Ostmark	245	184
Slovakia and Moravia	50	53
Poland	1,409	1,381
Japan	1,043	1,007
British India	945	850
Ecuador	830	867
Saudi Arabia	1,019	13
Sarawak	485	584
Egypt	1,577	421
Italian Empire: Albania	583	227
Italy	33	37
France	192	201
Hungary	275	72
Bolivia	33	37
Other Countries	223	28
WORLD TOTAL	768,412	738,530

Official Crude Oil Production Figures for 1932 to 1938 (Revised) in Metric Tons

	1938	1937	1936	1935	1934	1933	1932
United States	163,228,715	172,822,797	148,707,864	134,912,143	122,913,903	122,601,191	106,289,292
Soviet Union	28,859,000	27,867,025‡	27,384,900	25,241,100	24,092,700	21,330,100	21,389,300
Venezuela	27,845,286	27,733,926	22,945,299	21,990,373	20,112,115	17,293,193	17,085,334
Iran	10,358,495	10,330,480	8,329,289	7,607,500	7,657,970	7,200,093	6,548,941
Netherland India: Sumatra	4,662,836	4,490,137	4,114,710	3,759,006	3,535,035	2,999,352	2,492,742
Borneo	1,719,783	1,739,607	1,773,545	1,815,998	1,924,234	2,013,849	2,043,707
Java	933,595	960,125	499,097	464,757	510,320	483,331	515,187
Ceram	81,560	72,139	50,446	41,862	36,738	38,300	41,605
Roumania	6,603,000	7,153,000	8,704,000	8,394,000	8,473,355	7,387,000	7,350,321
Mexico	5,716,423	6,896,657‡	6,090,842	5,973,955	5,666,857	5,049,109	4,870,175
Iraq	4,345,000	4,126,185‡	4,079,066	3,724,231	1,048,108	147,943	118,887
Colombia	3,007,935	2,844,251‡	2,614,092	2,452,635	2,416,432	1,833,606	2,287,835
Trinidad	2,472,943	2,181,676	1,862,796	1,642,446	1,533,122	1,345,532	1,425,009
Argentina	2,432,857	2,330,063	2,202,304	2,036,903	1,997,706	1,950,499	1,871,882
Peru	9,099,885	2,313,691	2,331,454	2,260,903	2,161,990	1,756,867	1,311,856
Bahrein	1,130,734	1,058,557	635,555	173,072	39,008	4,293	123
Burma	1,039,960	1,083,391	1,047,593	991,456	1,004,951	982,233	976,589
Canada	876,016	378,430	190,495	182,820	178,233	144,686	131,937
Brunei	707,123	576,545	470,991	471,842	386,478	290,808	171,432
Great Germany: Old Reich	552,074	453,451	444,600	427,400	317,500	238,600	229,700
Ostmark	63,468	33,010	7,473	6,616	4,172	860	120
Slovakia and Moravia	19,282	17,936	18,665	19,946	25,971	17,776	18,493
Poland	504,678	501,301	510,630	614,760	529,200	550,670	556,680
Japan	356,328	341,040	341,976	326,580	266,520	212,667	239,567
British India	322,125	298,450	273,137	281,072	265,341	224,879	240,767
Ecuador	319,877	306,326	275,293	245,434	231,947	229,578	226,423
Saudi Arabia	66,683	8,070	2,447	Nil	Nil	Nil	Nil
Sarawak	200,126	217,085	221,126	253,799	277,513	315,259	332,819
Egypt	223,058	166,298	177,491	176,436	214,671	232,437	265,055
Italian Empire: Albania	65,313	56,760	32,760	6,152	2,500	1,707	1,375
Italy	13,178	14,000	16,106	15,977	20,180	26,526	27,046
France	72,106	71,008	74,788	74,172	98,025	110,120	105,758
Hungary	42,798	13,910	13	Nil	Nil	Nil	Nil
Bolivia	13,262	15,487	13,197	20,540	19,858	14,085	5,284
Other Countries	34,080	10,000	5,300	4,600	9,100	7,700	10,500
WORLD TOTAL	270,979,582	279,495,814	240,539,340	226,410,486	207,970,753	197,024,849	179,181,741

WORLD PETROLEUM ABSTRACTS

Summaries of the Most Important Articles as Published in the Oil Press of the World Dealing With Technical and Economic Aspects of the Petroleum Industry. Edited by Dr. O. W. Willcox

GEOLOGY

Soil Analysis Evaluated by Means of Test Holes—Mitchell Tucker, in OIL AND GAS JOURNAL, vol. 38 (1939), No. 5, pp. 36–37.

Soil analysis surveys are considered as one of the tools in the hands of competent geologists. A determination of the hydrocarbon content of the soil is often an important indication of the presence of workable petroleum deposits underneath. However, if information of this sort is to be of real use, the extent of soil sampling should not be too limited by a skimpy economy. Short sample lines should be avoided. They should extend outward on each side of the prospect sufficiently to establish the normal hydrocarbon content of the soil in that particular area, and thorough enough to afford closure markers on all sides. Some dry holes located by soil analysis have been chargeable to failure to do enough work for a rational interpretation.

It has been established in practice that soil analysis cannot give, reliably, a quantitative appraisal of petroleum possibilities; values known to reflect commercial production in one prospect cannot be transferred to another; it is necessary to find anomalies. If such anomalies are found, it only remains to establish normal on both sides and have a well-defined hyperbola directly over the prospect. Significance is usually attached to any well-defined anomaly which is 150 to 200 percent above the established normal for the region. Examples are cited to methods, applications and results and how they have been corroborated by experience.

NOTE—A company which specializes in soil analysis service has published (Ibid.) a record of its operations in Illinois, Kentucky, Alabama, Mississippi, Louisiana, Arkansas, Texas, Oklahoma, Kansas and New Mexico. In a total of 45 cases where the indications of soil analysis were tested by the drill, production was found in 22 recommended locations, 13 dry holes were drilled against the recommendations of the soil surveyors and 10 dry holes were found where soil surveys had indicated a prospect. On this record it would appear that soil analysis as an aid in oil prospecting is something more than 70 percent accurate.—ED.

Oil Production from Pre-Cambrian Rocks in Kansas—Kenneth K. Landes, before AMERICAN ASSOCIATION PETROLEUM GEOLOGISTS, Oklahoma City Meeting, March, 1939.

A few wells on the Central Kansas uplift are producing from pre-Cambrian rocks. The occurrence of oil in commercial quantities in rocks of this age is unique. The producing wells are in the Orth pool of Rice County and in the Gurney and Hall pools of Russell County. The pre-Cambrian rock in the Orth pool is quartzite, in the Russell County pools, granite. The latter consists of unweathered pink feldspar, quartz, and biotite. It is in place, and is not granite wash or even residual soil derived from granite. The only porosity conceivable in such a rock is that which would be caused by fissuring. It is suggested that the oil migrated into cracks near the top of the pre-Cambrian rock from topographically lower basal conglomerate which laps up on the flanks of the granite hills.

GEOPHYSICS

Structures in Sparta-Wilcox Trend Disclosed by Magnetics—Wm. A. Barret, in OIL WEEKLY, Vol. 93 (1939), No. 10, pp. 42–43.

Recent results indicate that magnometric surveys may be suited to disclose anticlinal structures in the Sparta-Wilcox trend, for the following reasons:

The surface materials which cover the trend are but feebly magnetic, and hence do not disturb or obscure the magnetic effects arising at depth.

The magnetizable basement rocks lie at such great depths in the trend that their magnetic reflection will not interfere with the anomalies traceable to folding in the sedimentary section.

The Wilcox section is the shallowest lithologic unit encountered in the trend which carries appreciable quantities of magnetic material, and because of its magnetizable properties and great thickness, the principal magnetic anomalies of local areal extent observed in the trend probably will be due to folding in the Wilcox section.

This set of conditions should result in a definite magnetic reflection of Wilcox structures. Experience indicates that it does.

A map illustrates the results of one form of magnetometric survey carried over the Cheneyville and Eola oilfields. The contours show how the anomalous vertical intensity varies throughout the area covered.

It is seen that, in both the Cheneyville and Eola fields, the present oil-producing areas are embraced by closed contours which represent magnetic highs, or maxima, and that displaced northward from these maxima there appear closed contours indicating magnetic lows, or minima.

It is believed probable that pronounced Wilcox structures, similar to those at Cheneyville and Eola, will give rise to diagnostic magnetic anomalies of the type shown.

Seismograph Prospecting for Oil, a Symposium—by Walter A. English and others, in PETROLEUM TECHNOLOGY, Vol. 2 (1939), No. 2, Technical Publication No. 1059, 29 pages.

The four papers making up this symposium have been prepared especially for those who have no knowledge of seismograph prospecting. To many people, mathematics is a formidable subject, and many are discouraged from studying seismograph prospecting under the mistaken assumption that the mathematical requirements are severe. In the papers presented here, there is not a single mathematical equation. It is believed that considerable competence in dealing with some of the most important problems of this work can be attained without any mathematical training whatever.

From that standpoint, Willard H. Tracy proceeds to expound the non-mathematical theory of seismic reflection prospecting, so that an ordinarily intelligent layman can understand what the practical seismologist really is looking for, namely, reflected waves as distinguished from useless other waves. The instruments used in reflection seismograph prospecting are explained by Arthur Norman. The carrying out of seismograph field operations is described by Frank Ittner. The whole thing reduces to the seismologist's recording the travel times of reflected waves from a common source, and to his translating these into travel paths of known position. The final determination of geologic structure from seismograph records is discussed by P. C. Kelly; it is chiefly a matter of picking out reflections from the records; skill in making the picks, and experience in seeing how the structures they indicate eventually check out is of more importance than training in physics or geology. The fundamental assumptions of wave travel in the earth are simple and understandable, and with these assumptions, the computation reduces to simple arithmetic and a few problems in solid geometry.

Exploration by Soil Analysis Methods—Malvin G. Hoffman, in OIL AND GAS JOURNAL, vol. 37 (1939), No. 44, pp. 23–24; 115.

The present tendency in searching for oil is to check a suspected structure so completely that the possibility of drilling a dry hole is reduced to a minimum. This means that all possible sources of information should be drawn upon, including geological investigations and the recognized geophysical tests.

To these recognized indicators of the probable presence of petroleum deposits there has recently been added another———analyzing the soil for the presence of gaseous, liquid and solid hydrocarbons.

This drafting of the soil chemist into service as an oil prospector is based on the following considerations: Oil and gas are trapped in porous formations beneath the surface, where they exist under high pressure and mostly at rather high temperatures. Under these conditions, both oil and gas tend to escape by diffusion through the microscopic pores of even the hardest and supposedly the most impervious rocks. The diffusion process may be slow, but in the course of ages, traces of hydrocarbons reach the surface soil. Naturally, the soil over an oil deposit will contain more hydrocarbons than soil further removed. Hence, by making a chemical survey of a considerable area, the position of an oil deposit can be more or less clearly indicated.

The Russians have used soil analysis for a number of years as a means for locating oil and gas. They have had a moderate degree of success. They do not analyze the soil but the gas from the soil. They drill a hole from 6 to 10 ft. deep, the lower half of which is smaller than the upper

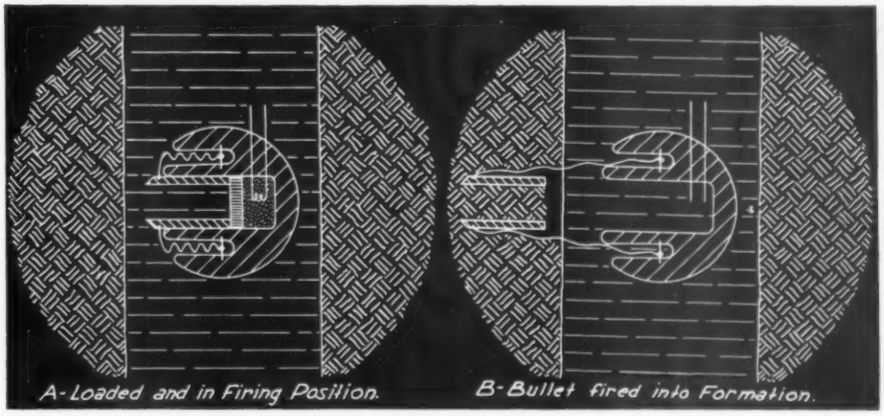
half. A bell is driven upon the shoulder, left about half-way down, and through it the gas is extracted from the soil by means of a vacuum pump. The gases collected and analyzed are almost entirely methane and ethane.

The American method is to collect samples of the soil and then distill off the hydrocarbons which range from methane through the heavier gases to waxes and asphalts. In practically all the American experiments methane is disregarded, because it is both a product of organic decay and a vapor from crude oil. The proportions of each cannot be separated.

The method of examination of an area depends upon the amount of detail desired. Samples are taken in lines crossing an area, radiating out from a center hub, or crossed in two sets of parallel lines as a net. The hydrocarbon values of these samples may be plotted as curves, or spotted as points on a map and then contoured.

Three principal types of curves have been developed over producing areas. One is the halo curve found over closed anticlinal structures; another is the high anomaly curve over the stratigraphic trap; and the third is the high peak found over a fault associated with oil accumulation.

Used alone, the soil analysis may not be conclusive; it should be considered along with other information.



Method of exploring drill holes by sample-taking bullets.

DRILLING

Exploring Drill Holes by Sample-Taking Bullets—Eugene G. Leonardon and D. C. McCann, in PETROLEUM TECHNOLOGY, Vol. 2 (1939), No. 2, Technical Publications No. 1062; 13 pages.

The search for oil requires a large amount of information on the structure, composition, physical properties and history of sedimentary rocks. The most complete source of information is the sample or core of the rock itself. For reasons of time and expense, however, it usually is not practicable to core the entire length of a drill hole. In practice, coring is limited to what appear to be the most interesting sections, together with study of the drill cuttings—a procedure which involves the risk that key horizons may be passed or overlooked.

The only continuous record of the formations encountered in a well is that furnished by electrical surveys. This suggests that an electrical survey be made of the well and samples taken from the wall of the hole according to the indications of the electrical log. Thus, corings are limited to the exact sections desired, and uncertain estimates of depth are eliminated.

This paper discusses a method of coring a well on this principle. The method is relatively simple, and is similar to that of the gun perforator. A bullet in the form of a hollow cylinder is fired into the formation by igniting a powder charge. By means of attached wires the cylinder, with its enclosed core, is hauled up to the surface for examination by the usual processes of core analysis. The general idea is indicated in the accompanying diagram.

In order to take a number of side cores during one trip into the well a number of bullets, with their wires and firing arrangements, are attached to a long gun; the charges are fired in succession as the gun is raised up in the bore hole. Cores are ¾ in. in diameter and 1½ to 2½ in. long, depending on the bullet used. Recoveries are about 70 percent; an 18-bullet gun may yield 12 to 15 cores. For the best work, the well-hole should be at least 5 in. in diameter.

This method is a valuable complement to electrical logging, as it affords a means of clearing up obscure relations on which the electrical log does not give conclusive information. It is often desirable to verify the position of water zones and to determine whether resistent zones are oil, gas, or both, and even to decide whether a given stratum is oil or water-bearing. The electrical resistivity frequently does not define, clearly, the oil gas or oil-water contacts. Examples are quoted to show how such problems are solved neatly.

Selective Exclusion of Water from Wells—Paul D. Torrey, before AMERICAN PETROLEUM INSTITUTE, New Orleans Meeting, May, 1939.

This paper, which covers 47 pages printed in double column, is devoted principally to squeeze cementing, plugging back, gun perforating, and other modern practices in the completion and reconditioning of oil wells.

Case histories in various fields of Texas, Louisiana, Arkansas and Illinois, where squeeze cementing has been employed for the reduction of high gas-oil ratios and for the exclusion of water, are presented. Maximum squeeze pressures in excess of 3,000 lb. per sq. in. appear to give the best results for the reduction of high gas-oil ratios, and maximum squeeze pressures of approximately 4,000 lb. per sq. in. appear to give the best results for the exclusion of water. Squeezing in close proximity to the gas-oil contact or to the water-oil contact is essential. Squeezing is generally much more effective through gun perforations in the casing than in open hole. Of the various records studied, 44 percent were entirely successful in the reduction of high gas-oil ratios, and 61 percent were entirely successful in the exclusion of water. The employment of higher maximum squeeze pressures, gel types of cement, and multiple-batch jobs, is increasing the percentage of success that is being obtained from squeeze cementing. The results from squeeze cementing may not be permanent when there will be readjustments in the gas-oil and the water-oil contacts in the reservoir.

Various plug-back methods for the exclusion of water are described, and particular reference is made to results that have been obtained in various West Texas fields, in the Rodessa field, and in the East Texas field. No squeeze-cement job for the exclusion of water has been entirely successful in the Permian lime fields of West Texas. In the Rodessa field very good results have been obtained by cementing a short string in the bottom of the hole and then gun-perforating for production. Many plug-back methods have been used in the East Texas field, but no one method appears to be universally applicable. Past experience has shown that about 50 percent of the attempts made have resulted in failures. New technique in placing the cement so that the casing may be protected from excessive pressures, and the use of gel types of cement, have indicated more promising results.

Owing to low allowables and the use of small-size chokes, there does not seem to be any great difference in the productivity of wells completed by gun perforation and of wells completed by the setting of conventional liner and screen. Gun-perforated well completions permit a close control of oil production, and provide an easy means for remedial work at some future time.

New chemical methods for the exclusion of water are assuming considerable importance.

Design of Casing Programs—J. O. Hills, before AMERICAN PETROLEUM INSTITUTE, New Orleans Meeting, May, 1939.

By design of casing programs is meant the selection of suitable casing sizes, weights, grades; type of joints; and hole sizes to be used in a particular well to perform most safely and economically the functions of water shut-off and protection at depths predetermined by geological considerations. The term casing-program design as herein used is not intended to cover design of casing, but rather covers a method of choosing from available stock the particular casing most suitable for a given well.

Published figures on setting depths in the past have encouraged selection of casing by methods which failed to recognize actual conditions and therefore, failed to assure either safety or economy. At best, these methods apply only to average field conditions and simple cases, and are far from correct in many instances. A pressure gradient of ½ lb. per sq. in. per ft. of depth is assumed and may result in large errors, because cases have been reported of formation pressures requiring 172 lb. per cu. ft. of mud, or a gradient of 1.19 lb. per sq. in. per ft. In addition to this, implied strength data on both tension and collapse have been generally unreliable and inconsistent. As a result, casing programs often have been chosen with little recognition of actual loading, and with no reliable knowledge of the strength of the pipe.

The importance and cost of casing programs justify careful engineering design based on the best available information on strength and loading conditions. A method of design is outlined which considers actual conditions, and which

results in a consistent compromise between economy and safety. Factors influencing choice of sizes, weights, grades, etc., are discussed; method of tabulation is shown; and an example of design is included. Collapse and tension data are given primarily to illustrate the method, but are believed to be the most reliable available at the moment.

OPERATING

Effects of Acid Treatment Upon the Ultimate Recovery of Oil from Some Limestone Fields of Kansas—R. E. Heithecker, in BUREAU OF MINES REPORT OF INVESTIGATION, No.3445, April 1, 1939; 47 pages.

In Kansas, almost every oil well drilled into a limestone formation is treated with hydrochloric acid upon completion. This is done to increase the potential capacity of the well and thereby increase its daily allowable production, to shorten the time required to produce the recoverable oil, and to increase the quantity of oil recovered ultimately from the reservoir.

Acid treatment of wells may be credited with extending the productive limits of some limestone fields in Kansas. Edge wells, which showed only small, non-commercial quantities of oil, have been completed as large oil wells after acid treatment, either alone or after being shot with nitroglycerin.

Many old limestone fields that almost had reached their economic producing limit were rejuvenated, and their capacity to produce increased several times. In the Fairport field (Russell and Ellis counties), production had declined to a daily average of about 10 bbl. per well. After the unprofitable wells had been treated with acid, the production per well averaged over 30 bbl. per day for a year. The rejuvenation of the Arbuckle limestone wells of the Eldorado field, Butler county, is another example. Many wells that had produced for 12 to 15 yrs. and had about reached their economic limits were rejuvenated through the use of acid and continued to yield large quantities of oil.

Limestone structures that had been tested by drilling and found non-commercial were completed later as commercial oil-producing formations through the use of acid.

Hydrochloric acid was used to treat oil wells in Kansas for the first time in October, 1932. The total number of acid treatments given to wells in Kansas by the end of 1937 was 8,070. These treatments consumed approximately 12,750,000 gal. of acid. The cost of the service to the operators is estimated at about $2,500,000.

Many changes have been made since 1932 by companies offering acid treatment service. It is claimed, for example, that when certain chemicals are added to the hydrochloric acid, more favorable results may be expected in certain limestone reservoirs, whereas the admixture of entirely different chemicals to the acid improves results in other areas.

Stage or multiple treating of wells with acid in many instances has proved to be an improvement over the older method of placing all the acid in the well at once.

There is no definite rule to govern the amount of acid to be used for treating an oil well. The operator usually is guided by the practice of other operators in nearby wells. At first, 1,000 gal. per well may be used; then 2,000 or 3,000 gal., while treatments of later wells may consist of 8,000 to 12,000 gal. charges introduced by stages.

The paper gives many details of operations and results.

Bottom-Hole Measurements in Pumping Wells—J. J. Jakosky, in PETROLEUM TECHNOLOGY, Vol. 2 (1939), No. 2, Technical Publication No. 1059; 23 pages.

This paper stresses the uses and importance of production studies through measurements of bottom-hole pressure at various rates of production.

There are two principal methods of making such measurements. One is to sink into the well a pressure gauge (or bomb) which records the pressure at various depths to the bottom. The use of such a gauge requires, on a pumping well, pulling the rods and at times even the tubing; various other factors make such measurements rather expensive.

A more convenient method is to determine fluid levels in pumping wells by the sonic or sound-wave reflection principle, which is given chief consideration in this paper, more particularly the Echo-Meter System. With this outfit, production-potential measurements can be made quickly and economically at static and two or three pumping speeds. This method has been made legal for prorating wells in certain fields of Kansas, and similar legislation is being enacted by other states.

Aside from that, this convenient method may be applied with advantage in other directions. A recent application of fluid-level measurements in East Texas is in connection with existing or projected gas-lift installations. If a well is being converted from pumping to gas lift, it is convenient to be able to obtain the fluid level in the annular space in advance of the pulling job. Also, the draw-down at various pumping rates will give valuable information regarding the size of valve to be installed. After the installation is completed, its operation can readily be checked quickly and conveniently by fluid-level observations. If it is suspected that a valve is sticking, a close check of the fluid-level variation when the well begins to unload will show which valve is kicking off.

In wells where insert valves of the conventional type are used, it is impossible to run a bottom-hole pressure bomb because the valves obstruct the tubing. In all gas-lift work, the Echo-Meter measurements have the additional advantage that the fluid level can be watched continually and the input pressure properly regulated, whereas with the pressure bomb gas can blow through the bottom perforations without the occurrence becoming evident until the run is finished and the bomb recovered.

Multiple Sand Completion of Wells Using Removable Casing—Harry F. Simons, in OIL AND GAS JOURNAL, Vol. 37 (1939), No. 52, pp. 49–50.

Where a well penetrates two producing oil sands, the operator has a choice of procedures. The least complex, but expensive, is to drill separate wells to each sand. However, it is much more economical to produce both sands through one hole, but obtaining satisfactory producing conditions in the upper sand is often difficult.

Lately, the Carter Oil Co. has developed a method of handling two pay zones in the Southern Illinois basin that allows each sand to produce as effectively and efficiently as they could by drilling two holes; the main feature of this method is a removable pipe section which is run in the casing string so that it will be opposite the upper sand (Cypress formation) when the casing is cemented. This section of pipe is then removed by mechanical means, or by acid, which leaves the Cypress section completely exposed. The situation then is that the hole is cased between the bottom of the Cypress and the top of the lower sand (Bethel formation), while the section opposite the Cypress is uncased.

NATURAL GAS

Catalytic Polymerization of Butanes from Natural Gas—F. B. Mack, before NATURAL GASOLINE ASSOCIATION AMERICA, Tulsa Meeting, May, 1939.

The Shamrock Oil and Gas Corp. has had 26 months' experience in the operation of a plant which employs a method for cracking and polymerizing natural butanes for the production of a high octane blending value motor fuel. This plant is operated in conjunction with a natural gasoline plant and a refinery which supply it with raw material. This raw material consisted of 600 bbl. daily of butane in excess of that contained in 26-lb. Reid vapor pressure natural gasoline, and could be increased to 1,000 bbl. daily by reducing the R.v.p. from 26 to 18 lb.

The butane delivered to the polymerization plant is charged to a cracking furnace which is controlled to permit the efficient production of olefins (unsaturates). In this process of cracking and catalytic polymerization of butane, two products are obtained. The first product made is pyrolytic polymer, which is formed in the butane cracking furnace and removed from the bottom of the debutanizer. The second product obtained is catalytic polymer, which is made by polymerizing the olefins in the catalyst towers. The production of pyrolytic polymer is about eight to ten percent of the total polymer production.

This product has a blending value of 95 with 66-octane pressure distillate and 102 with 50-octane straight-run gasoline, the octane rating of the two blends being 72. Other blends comparable to aviation fuel are produced. The product is mostly used to blend the refinery gasoline to market specifications.

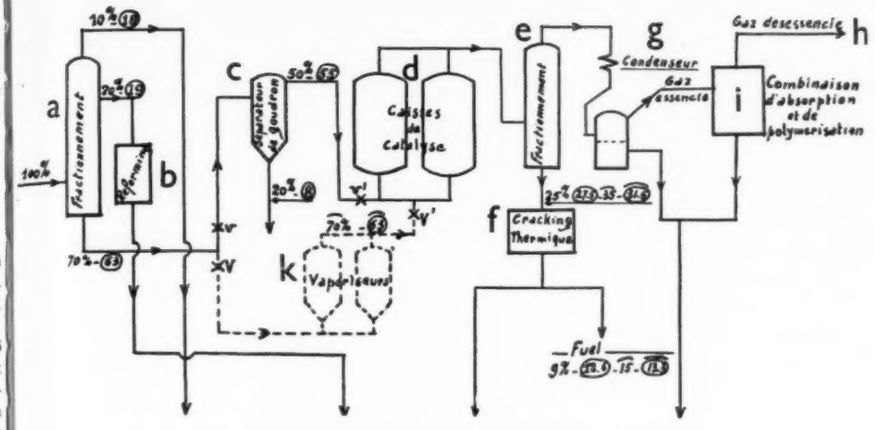
Details of operation and a discussion of economic considerations are presented in the paper.

Applications of Thermal Polymerization—Humble Oil and Refining Co., Phillips Petroleum Co. and M. W. Kellogg Co., before NATURAL GASOLINE ASSOCIATION AMERICA, Tulsa Meeting, 1939.

This paper, prepared jointly by two oil companies and an equipment company, is a review of the actual results of several plants employing thermal polymerization for processing mixtures of butane and propane, and points out the possibility of economic use of this process by natural gasoline operators. No comparisons are made with other processes, such as catalytic operations. The two plants chiefly considered are the Humble refinery, Baytown, Texas, and the Phillips Petroleum Company's refinery at Borger, Texas. The layouts at these plants are shown by flow diagrams.

For the Baytown unit, a description of flow is given, as well as a table of economics for the plant. Based on a butane charge of 8,000 bbl. per day, a 400 deg. endpoint poly gasoline value of six cents, a plant capital write-off of 10.5 years, butane is calculated to have a value of 1.615 cents per gallon in the feed tanks at the poly plant.

Similarly, for the unit at Borger of the Phillips Petroleum Co., description of flow and operating conditions are given as well as economics



Flow diagram of the Houdry Catalytic Cracking Process.

applying at this location. Economics of Borger operation indicate a butane value of 0.602 cent per gallon, with a gasoline value of five cents.

Suggested design is given for thermal polymerization to be used at natural gasoline plants. This includes consideration of size of plant, butane and propane, as feed stocks, and use of existing plant facilities. General economics are given for one case in which 400 bbl. per day of 10-lb. R.v.p. 400 deg. endpoint poly gasoline are produced daily from 40,000 gal. of butane charge. It is indicated for this illustration that in a 3-year capital amortization, butane ranges in value from 0.36 cent per gallon with poly gasoline at 4.0 cents per gallon to 1.21 cents per gallon where the 10-lb. R.v.p. 400 deg. endpoint poly gasoline has a value of six cents per gallon.

Compressibility of Hydrocarbon Gases—B. H. Sage and W. N. Lacey, before CALIFORNIA NATURAL GAS ASSOCIATION, April Meeting, 1939.

The compression of hydrocarbon gases is of importance in many of the operations involved in the production, transportation and refining of petroleum. The increasing use of repressuring in the field and high-pressure processing in the plant has necessitated the engineering treatment of the compression of large quantities of gases to relatively high pressures. Under these circumstances some of the methods that have been employed in the estimation of compressor performance are open to uncertainties and there is possible advantage to a more fundamental treatment of this essentially thermodynamic process.

This paper discusses the thermodynamic relationships describing the compression of gases and presents a comparison of the behavior estimated from such relationships, based upon factual information, concerning the thermodynamic properties of hydrocarbon materials, with the performance determined experimentally. In addition, data regarding the thermodynamic behavior of a number of mixtures of methane and ethane have been included as well as a discussion of the results obtained in an experimental investigation of compressor performance. Certain experimental information concerning the behavior of a particular compressor is necessary or must be assumed in order to estimate the performance. For example, if the fluid friction and energy rejected to the jacket can be correlated as a function of the average gas temperature, the rate of compression and possibly the viscosity of the gas, the performance of the compressor may then be estimated for any other fluid for which suitable thermodynamic data are available. The information so obtained will include the work of compression and the outlet gas temperature. If indicator cards are available for the machine operating on the fluid in question the maximum gas temperature may be predicted with accuracy and the indicated work compared with that obtained from the state of the entrance and exit gases.

TRANSPORTATION

Design and Construction of High-Pressure Gas Lines—John A. Clark, in PIPE LINE NEWS, vol. 11 (1939), No. 5, pp. 3–4.

The author discusses the design and performance of a 12-in. all-welded seamless pipeline delivering natural gas from Kanawha County, W. Va., to Ohio markets.

Since its completion the company ran a series of tests that gave some interesting results. It was found that as the pressure was increased the carrying capacity of the line was considerably above that shown by the standard Weymouth pipeline formula approved by the American Gas Association. As is well known, natural gas is not a perfect gas, but at high pressures compresses more than a perfect gas would. The tests showed that the carrying capacity of the line increased over the capacity indicated by the A.G.A. formula by a percentage approximately the same as the super-compressibility of the gas at the average pressure in the line. The super-compressibilities of a number of gases common to the region were tested, and were found to vary from zero percent at atmospheric pressure to as high as 36 percent to 1,500 lb. and 40 deg. temperature.

In other words, the high-pressure line will exceed the capacity expected from the standard formula at an average pressure of 300 lb. by six percent; at 500 lb. by 11 percent, and at 1,000 lb. by 24 percent for an average dry gas. Equipment was not at hand to go above 1,000-lb. pressure with any large volume of gas, so no statement is made about results above that pressure.

The practical result is that in designing the line it was expected to pass 63,000,000 cu. ft. per day with 1,000 lb. pressure at Cornwell and 320-lb. at Hastings (95 mi. distant); it turned out that at these pressures the delivery is 74,000,000 cu. ft. a day; or, a 12-in. line at the stated pressures has practically the same carrying capacity as a 20-in. line operated at 350 lb. initial and 100 lb. outlet. The difference in the cost of constructing a 12-in. and a 20-in. line is $1,000,000 per 100 mi.

REFINING

The Houdry Catalytic Cracking Processes—Houdry, in BULLETIN ASSOCIATION FRANCAISE TECHNICIENS PETROLE, No. 49 (1939), pp. 3–14.

In this address, the author explains with flow sheet the application of the Houdry process to Iraq and to East Texas crudes. The crude oil at a suitable temperature is admitted to a fractionating tower where it is fractioned into straight-run gasoline, a naphtha for reforming, and a residue which, after elimination of the heaviest products (tars) in a separator, is used for charging the catalyzing chambers.

The catalytically cracked products are next admitted to a fractionating tower. The light products from this tower are sent through a separator to obtain catalytic gasoline and gas for the absorption and polymerizing department. The tail product is an excellent gas oil which may be sold as such or cracked again either catalytically or thermally. This residue is particularly suitable for thermal cracking, especially since most refineries possess the appropriate equipment.

This treatment (with residue) of Iraq crude yields a total of 6.15 percent of 74.7 octane gasoline and 20 percent of residue (tar). A similar treatment of East Texas crude yields 74.2 percent of 74.4 octane gasoline and eight percent of residual tar. The treatment can be shifted to a process operating without residue by shutting two valves V and V^1, and opening v and v^1. In the flow sheet, the lettering marks the following stations (heat exchangers omitted): *a* fractionating tower, *b* reformer, *c* tar separator, *d* catalyst chambers, *e* fractionating tower, *f* thermal cracking, *g* wet gas condenser, *h* dry gas, *i* combination absorption and polymerization, *k* vaporizers. Figures in circles refer to East Texas crude, others to Iraq crude.

Reference is made to an unpublished process of operations without residue which has been applied in a pilot plant (300 tons daily) at Chicago with the following results as of March 17, 1939:

	Percent
Charge to catalyst	100.04
Sulphur in crude	2.10
Gasoline yield:	
volume	47.2
by weight	37.5
Gas oil:	
volume	52.0
by weight	50.8
Total carbon deposit	7.2
Dry gas (by weight):	4.5
Octane no. of crude gasoline	79.2
Sulphur in crude gasoline	0.2
Yield of liquid of all products: between vaporizer and catalyst chambers are condensed	100.2
Carbon deposited in vaporizer	2.4

Applied to East Texas and Iraq crudes, this new process gives the following for Iraq crude: gasoline yield 76.5 percent, octane number 75.3; East Texas crude, gasoline yield 80 percent, octane number 74.7. Aviation gasoline is obtained with the same apparatus making a different series of cuts and applying a special catalytic process.

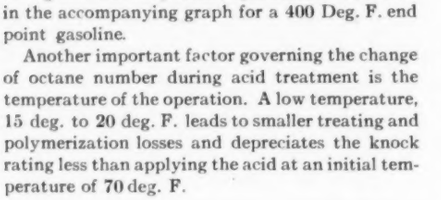
Factors in Knock Rating and Lead Susceptibility of Gasolines—Francis S. Graves, in INDUSTRIAL ENGINEERING CHEMISTRY, Vol. 31 (1939), No. 7, pp. 850–856.

Previous investigations have indicated a loss of knock rating during the acid treatment of cracked gasolines; there has been a disposition to regard this loss of rating as dependent on the nature and source of the raw material. The present investigation relates the matter more particularly to various factors in the manufacturing process, especially the acid treatment. The commercially cracked naphthas used in this study were treated at three different acid rates. Each

raw naphtha and the corresponding acid-treated stocks were redistilled to obtain five different yields. Complete tests were obtained on the overhead gasolines and these tests were plotted against yield from the charge for each whole stock. It was thus possible to determine the tests of a gasoline of any desired end-point from each raw and treated naphtha.

The effects of these treatments on the knock rating and tetraethyl lead requirements are shown in the accompanying graph for a 400 Deg. F. end point gasoline.

Another important factor governing the change of octane number during acid treatment is the temperature of the operation. A low temperature, 15 deg. to 20 deg. F. leads to smaller treating and polymerization losses and depreciates the knock rating less than applying the acid at an initial temperature of 70 deg. F.



In connection with the relation between acid treatment and lead susceptibility of gasolines as depicted in the figure, it is noted that the sulphur content of the gasoline is of importance. Recent work has shown that tetraethyl lead may be saved by a previous desulphurization. This is of importance because excessive acid treatment may lower the knock rating, but where the gasoline is thus more extensively desulphurized, the ultimate lead susceptibility may be so increased that an increase in the amount of acid used may be an economical means of saving tetraethyl lead.

Field Installation of Chromium Sheet Linings in Pressure Vessels—J. I. Shales, before AMERICAN PETROLEUM INSTITUTE, New Orleans Meeting, May, 1939.

This paper describes the experience of the Standard Oil Co. of California with the protection of refinery vessels in the field, that is, vessels in service that had become corroded to the point where they had to receive a protective coating or be replaced by new equipment. As related by the author, the evolution of a successful practice was a long and more or less painful process of trial and error, due to difficulty in obtaining proper materials, the undeveloped state of the art of electrically welding stainless steel alloys, and ignorance of the proper method of bonding the lining to the sheet. By degrees the present method of strip lining was developed. In this method the metal sheets used for the lining are cut in strips 23 by 120 in. or other suitable dimensions. Holes 9/16 of an inch are punched on four-inch centers and the sheets are plug-welded to the wall of the vessel through these holes.

For linings in cracking service the metal conforms to the following chemical composition:

	Percent
Chromium	11 to 13
Carbon	0.08 (maximum)
Nickel	0.50 (maximum)
Manganese	0.30 to 0.70 (maximum)
Silicon	1.00 (maximum)
Phosphorus	0.035 (maximum)
Sulphur	0.035 (maximum)

The low carbon content of the material is believed to be the key to successful installation; it should be the minimum obtainable. The cost of the finished job may run from $5 to $10 per sq. ft., which has to be weighed against replacement cost, time lost, etc. Observations on about 50,000 sq. ft. of lining over an average period of six to eight years indicate the need of replacement at the rate of one or two percent a year. Most of the lining installations were made in 1928 to 1931 and the bulk of it is still in operation, with only minor maintenance. Similar linings have been installed in hot-oil circulating pump cases, phenol-extract recovery towers, vacuum distillation towers in crude distillation service, etc.

Manufacture of Iso-Octane—L. J. Coulthurst, in OIL AND GAS JOURNAL, vol. 37 (1939), No. 50, pp. 50–51, 61.

There has arisen a great interest throughout the world for 100 octane aviation fuel, the chief constituent of which is iso-octane, which is blended with straightrun gasoline and isopentane. A number of refiners are making efforts to meet the demand. Among this group is one that is operating the Foster Wheeler equipment for producing iso-octane by selective catalytic polymerization and hydrogenation processes as described in this article.

Feed stock for these processes consists of cracked gasoline that has been depropanized. Bottoms from the depropanizer column contain the butane-butene cut that is to be used for subsequent hydrogenation. The hydrogenation process selected uses a low operating pressure with a catalyst that consists of activated nickel. This catalyst is extremely susceptible to poisoning by sulphur with the resultant permanent loss of activity. Consequently, considerable care was taken to reduce the sulphur content in the charge stock to a minute quantity, which is done by subjecting it to a series of three contacts with caustic soda.

In the selective catalytic polymerization process, iso- and normal butene interpolymerize to form several isomers, among which are 2,2,4-trimethyl pentenes 1 and 2. In spite of the fact that there is a copolymerization of normal butenes, the resultant octane, upon hydrogenation, possesses a blending value equivalent to 2,2,4-trimethyl pentane and the mixture is known commercially as iso-octane.

After thorough desulphurizing the butane-butene feed stock is brought into intimate contact with an extruded-type catalyst contained in a high-pressure heat exchanger. The polymerization reaction requires that the temperature be controlled with definite limits, which is done by circulating boiling water through the shells of the catalyst vessels.

Hydrogenation of octenes to octanes may be accomplished in either one or two stages. Where the cost of hydrogen is relatively high and most effective use is therefore desired, two-stage hydrogenation is usually adopted and approximately 95 percent of the hydrogen may be utilized. In this particular installation, hydrogen was relatively expensive and a two-stage hydrogenation system was adopted. The octene charge from the selective catalyst polymerization unit is joined by unreacted hydrogen from the second stage and both are passed through a steam-heated preheater into the top of the first-stage hydrogenation reactor. Here it comes into intimate contact with a catalyst that promotes saturation of the hydrocarbons.

CHEMISTRY

Analysis of Oil-Wax Mixtures—H. D. Lord, in JOURNAL INSTITUTE OF PETROLEUM, Vol. 25 (1939), No. 187, pp. 277–287.

The estimation of oil in oil-wax mixtures by the press method is not very accurate, and, as the A.S.T.M. book states, "The expressible oil and moisture content does not bear a direct relation to the actual oil content of a given sample of paraffine wax."

In the present report, it is shown that a more accurate estimation of oil content, and therefore a closer control of refinery pressing and sweating operations, can be obtained by any one of the three methods developed involving measurement of:

(a) Specific gravity at 65 Deg. C.
(b) Aniline point.
(c) Refractive index at 60 Deg. C.

The gravity method is perhaps the simplest and most convenient to carry out, and probably represents the best method for routine testing of scales and sweated fractions; it is sufficiently accurate as a control test, giving results to within ±0.8 percent oil.

The refractive-index method is the most accurate of all, giving results to within ±0.5 percent oil, and if an Abbé or other suitable refractometer is available, it can be used conveniently. It is perhaps best suited to research or investigational work where the highest order of accuracy possible is desired.

The methods are, of course, applicable only to scales containing more than, say, two percent oil as an absolute minimum, and cannot be used for the estimation of oil in finished waxes.

For mixtures containing from 5 to 40 percent oil, the following equation applies:

Oil content (% by wt.) $= 1635\,[\mu_x - (\mu_o - 0.0007)]$

where

μ_o = refractive index at 60 deg. C. of oil-free wax.
μ_x = refractive index at 60 deg. C. of oil-wax mixture.

Solutizer Process for the Extraction of Mercaptans—D. L. Yabroff and L. E. Border before AMERICAN PETROLEUM INSTITUTE, New Orleans Meeting, May, 1939.

It is desirable to remove mercaptans completely from gasolines by extraction rather than to convert them to disulphides. Aside from a reduction in the total sulphur content of the gasoline, the most important effect is an improvement both in the initial octane number and in the lead susceptibility, as disclosed recently in the literature. In addition, improved light stability and inhibitor susceptibility may be expected in many cases.

Only partial mercaptan removal can be obtained by using aqueous caustic solutions, inasmuch as the heavier mercaptans are very difficult to extract. The degree of mercaptan removal can be improved somewhat by increasing the caustic concentration up to a certain point, but thereafter there is no improvement, and the extraction actually may become poorer.

The extent of removal of a mercaptan from an oil phase by an aqueous alkaline solution is a function of the ionization constant of the mercaptan and of the relative solubility of the unneutralized mercaptan in the aqueous alkaline phase. The ionization constants of the mercaptans are not affected greatly by an increase in the molecular weight, but the water solubility of the mercaptan is reduced markedly. Further, sodium hydroxide acts to salt out the unneutralized mercaptan from the aqueous phase, and this effect is greater for the heavier than for the lighter mercaptans. Failure, then, to achieve complete extraction of mercaptans from gasolines using aqueous caustic solutions is due mainly to the poor water solubility of the heavier mercaptans, and this is magnified by the salting-out effect of the sodium hydroxide.

It has now been found that addition of certain organic solvents or salts, called solutizers, to an aqueous alkaline solution increases the solubility of mercaptans in such solutions, with great increase in the extraction. Among these solutizers the most effective appears to be potassium isobutyrate; suitable proportions are four to six-normal free alkali and three-normal isobutyrate salt.

In practice the gasoline is first scrubbed with dilute caustic or tripotassium phosphate to remove free hydrogen sulphide, followed by the solutizer solution, which can be regenerated and used again. In pilot plant operations up to 99 percent of total mercaptans have been removed, though some west Texas straight-run products are more refractory. Solutizer treatment does not lower the octane rating, and may even increase it; in addition, the tetraethyl lead susceptibility is usually improved. When used in conjunction with an alkali phenolate, gum stability is maintained.

Fractional Distillation of Mixed Hydrocarbons Similar to Gasoline—R. Sigwalt, in BULLETIN ASSOCIATION FRANCAISE TECHNICIENS PETROLE, No. 49 (1939), pp. 14–37.

A detailed description is given of a laboratory fractionating outfit for the analysis of low-boiling liquids as employed in the research laboratory of Cie. Francaise de Raffinage. An example is given of the fractionation of a light gasoline. There was a good separation of isopentane and normal pentane, and also the different hexanes; the distillation curve was confirmed by the specific gravities. An efficient distilling apparatus of this kind is of great value as a first aid in analytical work on hydrocarbons; confirmatory tests remain to be applied to the separate fractions and the analyst should be on his guard against azeotropy.

Determination of Sulphur in Light Refined Petroleum Oils—W. A. Schulze, V. W. Wilson and A. E. Buell, in OIL AND GAS JOURNAL, vol. 37 (1939), No. 45, pp. 76–78.

This paper presents modifications of the Ethyl Corp. method which permit the operator to secure consistently reproducible results accurate to a degree heretofore unattained. The principal modification consists in the substitution of a carbon dioxide-oxygen mixture for the stream of purified air ordinarily entering the chimney of the combustion unit. Other variations consist in a lamp of 30 ml. capacity for fuels of low sulphur content, and a double endpoint titration insuring exact neutralization. The net effect of these modifications is to insure the accuracy of the method over the entire concentration range encountered in work with petroleum oils.

The reason for substituting the carbon-dioxide-oxygen mixture for air in effecting the combustion is that when using air some nitrogen is oxidized, producing nitrogen oxides and acids which partly neutralize the standard sodium carbonate solution used for absorption. Hence the back titration figure will show a higher sulphur content than is actually present. A tedious correction for nitrates is not necessary with this method. The amount of nitrogen contained in commercial oxygen gas is too small to affect the result.

PHYSICS

Preliminary Micromagnetic Survey of the Eola Structure—W. P. Jenny, in OIL WEEKLY, Vol. 93 (1939), No. 12, pp. 34–35.

A recent publication by Barret on a magnetic reconnaissance survey of the Cheneyville and Eola fields (Louisiana) has shown conclusively that these two structures yield magnetic anomalies which can be discovered by an accurate magnetic survey, even if the station interval is as large as one and a half miles.

The present author has made a preliminary magnetic survey of the Eola prospect and gives a map, showing more detailed data, which reveals a regional increase in the magnetic intensity due to a downdip thickening of the magnetic Wilcox section. This micromagnetic interpretation was made in the early days of February (1939) and has been substantiated by recent drilling.

The real existence of measurable magnetic trends in sedimentary rocks has been proven by the recent successful development of the polar core orientation method by which, from a laboratory study of cores taken from a well, it is possible to determine the dips of the strata penetrated by the drill.

The magnetic force found in the core naturally exists in the parent rock and may be evaluated by sufficiently precise measurements. Detailed micromagnetic surveys made by the author in the Anahuac field, the Amelia field and elsewhere, indicate that the lower Miocene acts as the main magnetic stratum. In southwest Texas, the magnetic method is credited with the discovery of a number of oilfields.

From his experience in the Gulf Coast, the Mid-Continent and Michigan, the author is satisfied that, within the near future, the magnetic regional survey will be recognized as one of the preliminary essentials in determining the location of wildcats as well as extensions to proven fields.

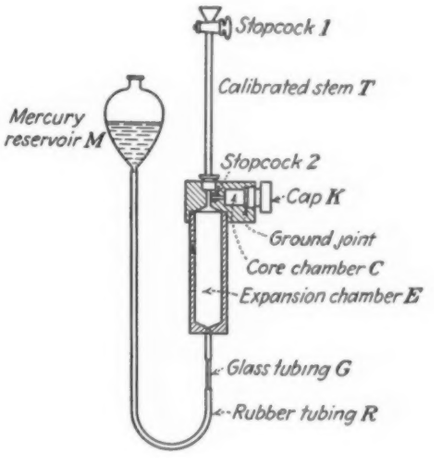
Relation Between Melting Point and Molecular Weight in the n-Paraffin series—A. H. Etessam and M. F. Sawyer, in JOURNAL INSTITUTE OF PETROLEUM, Vol. 25 (1939), No. 187, pp. 253–262.

The relation between the melting point and number of carbon atoms in the molecule in a homologous series provides an interesting study, and it is therefore not surprising that attempts have been made to derive a formula expressing the melting point in terms of the number of carbon atoms in the molecule. The *n*-paraffin hydrocarbons, by reason of their many syntheses and the consequent accumulation of data, are particularly suitable for such a study.

This paper deals with an interesting and fundamental relationship between melting point and molecular weight in the *n*-paraffin series. When the melting points of the odd and even members of this series are plotted against their respective molecular weights, it is found that the two categories lie on different curves. Hence no one equation connecting melting point and molecular weight will accurately represent both the odd and the even members over the whole series of *n*-paraffins. However, with an increase in the number of carbon atoms in the molecule, the curves tend to converge. From C_{22} onwards, the difference between the curves is so small that they may be regarded as coincident.

A New Device for Determining Porosity by the Gas-Expansion Method—A. B. Stevens in PETROLEUM TECHNOLOGY, Vol. 2 (1939), No. 2, Technical Publication No. 1061; 5 pages.

In the calculation of oil and gas reserves by volumetric methods, it is necessary to know the volume of the reservoir available for the storage of the oil or gas. To obtain this information there are a number of methods for determining the total and the effective porosity of reservoir rocks. The methods for determining total porosity only have the disadvantage that the samples are reduced to grain size in the determination. In many sands there may be little or no difference between total and effective porosity but in other sands there may be considerable difference between the two. For the estimation of oil and gas reserves, the effective porosity of the reservoir rock always should be used.



Of the methods that have been developed for the determination of the effective porosity of reservoir rocks, or the porosity that considers only those pore spaces that are connected, the best known are the so-called Boyle's law and the Washburn-Bunting methods. The Washburn-Bunting method is probably the most widely used because it gives effective porosity, it is rapid, and the apparatus is inexpensive. This method employs a special porosimeter in which the core sample is placed in direct contact with mercury. This method has disadvantages in that, as a result of the high vacuum created in the pore spaces, mercury is drawn into the openings, making it impossible to use the sample for a check determination and also ruining the sample for any further test, such as permeability. The purpose of this paper is to describe an apparatus employing the same principle as the Washburn-Bunting method but so designed that the core sample does not come in contact with the mercury in the porosimeter.

An Accurate Kinematic Viscosimeter for Refinery Control Laboratories—E. H. Zeitfuchs, before AMERICAN PETROLEUM INSTITUTE, New Orleans Meeting, May, 1939.

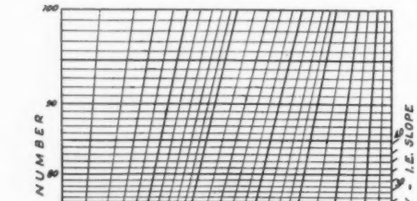
This paper describes the design, construction, operation and calibration of a practical viscosimeter that has been developed in the laboratory of the Standard Oil Company of California during the past six years. It not only meets the demand for greater accuracy in viscosity measurements, but has the further advantage of rugged construction.

The instrument is identified as the Zeitfuchs viscosimeter, and is a modification of the Ostwald type. It has features which make it particularly adaptable for routine testing. The use of this equipment has resulted in greatly improved accuracy, in comparison with that of the Saybolt instrument, and also an appreciable reduction in the labor requirement for viscosity determinations.

USES

Ethyl Fluid Chart for Motor-Method Octane Numbers—L. E. Hebl, I. B. Bendel and F. L. Garton, in INDUSTRIAL ENGINEERING CHEMISTRY, Vol. 31 (1939), No. 7, pp. 862–865.

A large proportion of the gasoline used for both automotive and aviation fuel is treated with tetraethyllead to improve the knock rating. The effectiveness of tetraethyl lead in improving different blending stocks varies considerably, and for this reason a considerable amount of experimental work may be involved in the preparation of leaded gasolines. This work is expedited by the use of a chart so constructed that when the



octane number of a treated gasoline is plotted against the amount of tetraethyl lead added, a straight line results. With such a chart the effectiveness of tetraethyl lead in different fuels can readily be compared in terms of the slope of the line obtained.

The authors have averaged a large number of tests carried out by the Motor Fuels Division of the C.F.R. Committee, and therefrom have prepared the accompanying ethyl blending chart for the A.S.T.M.–C.F.R. method.

The use of such a chart is self-explanatory and is analogous to the use of the A.S.T.M. viscosity-temperature charts. The octane numbers of a given gasoline at two or more concentrations of tetraethyl lead are necessary to establish the line on the chart for that gasoline. The slope of a line, parallel to the one through the plotted data, but drawn from the star at the lower left-hand corner to the scale at the extreme right, gives the lead susceptibility of the gasoline. With the aid of such a chart, interpolation gives directly the quantities of tetraethyl lead required for any desired octane number.

In the preparation of similar charts, the compression ratios of fuel of widely different octane ratings at various concentrations of tetraethyl lead are required. When this data is available, the chart is easily prepared according to the instructions given in the paper.

SUBSTITUTES

Chassis-Dynamometer and Road Tests of Alcohol-Gasoline Blends—C. W. Phelp and L. C. Lichty before AMERICAN PETROLEUM INSTITUTE, New Orleans Meeting, May, 1939.

This paper discusses the principal factors which affect the performance of automobiles using gasoline and alcohol blends.

Data presented from various laboratories show that alcohol is a good anti-knock blending agent, having a blending value, when used in small percentages, that ranges between 90 and 160—depending upon the type of gasoline used in the blend and the method of rating. In a blend of one part alcohol to nine parts gasoline by volume, the alcohol has the same anti-knock effect as between 0.5 and 1 ml. of tetraethyl lead per gallon.

In general, the blending value of alcohol decreases as the octane number of the base gasoline increases and as the lead susceptibility of the gasoline decreases.

Alcohol and tetraethyl lead are substantially independent in their action when both are mixed with a given gasoline. Obviously, the use of alcohol as an anti-knock blending agent is not justified economically unless the cost of alcohol is not more than the cost of the gasoline and lead it replaces.

Chassis-dynamometer, acceleration, and road tests with a gasoline and a 10-percent blend with alcohol, using six cars with various carburetor adjustments, are reported. In general, with standard carburetor settings approximately the same power and acceleration, but decreased fuel economy and mileage, were obtained with the blend as compared with gasoline—although exceptions to these results were noted. The blend was inferior to gasoline in all respects when lean carburetor settings were used.

Data presented from tests run by others with privately-owned cars, owner-driven, show slight decreases in mileage with the blend in summer, and appreciable decreases in mileage and ease of engine starting and warm-up with the blend in winter, as compared with gasoline.

The relative performance of automobiles with gasoline and alcohol blends depends primarily on carburetor settings and characteristics. Alcohol blends usually rate higher on the road than by the motor method.

Italy's Motor-Alcohol Campaign —(Annon.) in PETROLEUM ZEITSCHRIFT, vol. 34 (1938), Nos. 51-52, p. 15.

The attempt of the Italian motor fuel administration to promote alcohol productions to an extent that would allow 20 percent of absolute alcohol to be added to all gasoline used in Italy has encountered difficulties. The original expectation was that the necessary supply of alcohol could be obtained by enlarging the area in beets in the beet sugar districts of northern Italy, where the farmers would be paid an average price for their beet crops, which would be turned partly into sugar and partly into alcohol.

It now appears that the necessary acreage cannot be found in the existing sugar districts, and extension of beet culture into other districts unsuitable for beets is impracticable. The plan has therefore been altered by adopting sorgo as an additional crop that can be used as a source of alcohol, and which can be cultivated on poor soils not well adapted to other valuable crops such as hemp and tomatoes. The necessary pioneer work with sorgo has been completed and extensive acreages have already been planted.

The eagerness of the Italians to achieve a large measure of self-sufficiency in motor fuel is illustrated by a further move in which cactus fruits are to be used as raw material. It has been found that these fruits can be processed with good yields and that there are vast tracts in southern Italy and Sicily which are useless for other crops but are well adpated for flourishing cactus growths.

ECONOMICS

Relation Between Crude Oil and Product Prices—Sidney A. Swensrud, in Bulletin, AMERICAN ASSOCIATION PETROLEUM GEOLOGISTS, Vol. 23 (1939), No. 6, pp. 765–794.

The relation between crude oil and refined product prices has long been a source of discussion within the petroleum industry, and particularly since the inauguration of proration. When refined product prices have receded during times of oversupply or falling off in consumption, independent refiners have contended that they were the victims of a semi-fixed price of crude which did not similarly respond to the downward forces, or at least not soon enough to avert serious trouble for refiners. Crude oil producers, on the other hand, tend to place the blame for reduction in refined product prices entirely upon alleged mistakes within the refining branch and contend that if refiners would reduce their runs more effectively, accumulation of surplus stocks would be avoided and prices would hold. According to their view, prices of refined products should follow the price of crude and not vice-versa—at least when they are being lowered. The producers say that during times of reduced refinery prices, crude price reductions would merely cause further reductions in refined product prices, and so on, until ruinous levels resulted. The other view is that refined price changes naturally occur ahead of crude price changes because of the more sensitive nature of the refined product markets, but changes in refined product prices are not a primary cause of changes in crude, or vice-versa: rather both crude oil and product price changes fundamentally are the result of changes in the supply-demand relationships for the industry as a whole. There are, therefore, two main questions:

1. What are the facts as to the relationship existing, from time to time, between the price of crude oil and the value of the refined products produced therefrom?

2. What is the sequence in crude oil and product price movements?

On these questions the author has assembled a large volume of statistical material showing the lag of crude price adjustments behind changes in prices of refined products over the period 1920 to

1938 inclusive. The data clearly show the greater sensitiveness of refined prices and their more easy and frequent change than crude oil prices. It is evident that the lag in the downward movement in crude oil prices operates to the disadvantage of the refining industry, and that this lag has been more pronounced since State proration became a general practice about 1930. The statistics afford a defense for the producer against the charge that he has profited, in general, at the expense of the refiner under proration practices of recent years.

GENERAL

Eliminating Hazards in Welding Gasoline Tanks—W. E. Archer, in OIL & GAS JOURNAL, vol. 37 (1939), No. 46, p. 175.

Much effort has been spent in attempts to perfect a process or method which will eliminate the danger of fire or explosion in making weld repairs on gasoline, fuel oil and storage tanks. Usually a thorough cleaning is considered a necessary preliminary to such operations.

A procedure adopted by a Los Angeles mechanic is to force the air out of the tank by inert gas from the exhaust of a gasoline motor, usually introduced from below. Complete expulsion of inflamable vapors is ascertained by testing a sample of the outflowing gas before welding operations are started. It is even said that by thus expelling the air operations can be conducted on a tank containing liquid gasoline. To produce 3,000 cu. ft. of inert gas requires combustion of one gallon of gasoline.

Competent persons who have looked into the proposition are of the opinion that it is reasonably safe if accurately carried out by skilled and competent workmen, otherwise it still has an element of danger.

Dehydration of Organic Liquids with Activated Alumina—R. B. Derr and C. B. Willmore, in INDUSTRIAL ENGINEERING CHEMISTRY, Vol. 31 (1939), No. 7, pp. 866–868.

The solubility of water in many organic liquids, including gasoline and solvents used for extraction purposes, is very low, but in many cases is important enough to interfere with the engineering and commercial use of the solvent. In such cases, a rapid and economical method of dehydration is a desideratum. Activated alumina, which will absorb nearly 10 percent of its weight of water, is an excellent agent for the purpose. A commercial unit of two adsorbers 40 in. in diameter and nine ft. high, each containing 2,500 lb. of alumina, will dry 100,000 gal. of benzene, 200,000 gal. of toluene, or 1,000,000 gal. of gasoline per cycle of 2.5 hours. Regeneration of the alumina is easily accomplished by heat applied either by coils embedded in the material or by circulating a hot inert gas, such as methane. The moisture content may be reduced to a final specification of less than 0.01 percent.

Catalytic Activities of Two Allotropic Forms of Nickel—G. Leclerc and H. Lefebvre, in COMPTES RENDUS ACAD. SCIENCES FRANCE, 1939, pp. 1650–1651.

There are two allotropic forms of nickel. One is obtained by the reduction of nickel oxide by means of hydrogen at a temperature of about 250 deg. C. It has the cubic crystal form and has magnetic properties. When this cubic magnetic nickel is kept for several days at about 175 deg. C. in an atmosphere of carbon monoxide and hydrogen (Fischer-Tropsch synthesis gas), the products are water and hydrocarbons. Examination of the nickel by X-rays and thermomagnetic analysis now shows that it has passed to the hexagonal crystal form and has lost its magnetic properties without any apparent change in the size of the crystal; the catalytic efficiency is also depreciated. The initial catalytic activity, and also the magnetic property, may be restored by heating for several hours at 280 deg. C. in a vacuum or in an atmosphere of nitrogen.

Higher Octane Ratings Shown in 1939 Trend—W. I. Ziegenhain, in OIL AND GAS JOURNAL, Vol. 38 (1939), No. 4, pp. 25–27.

On the basis of an annual survey conducted by buying and testing 36 samples of gasoline from each of 12 companies, it is concluded that better quality gasolines are now available at filling stations than at any time in the past. The average octane number of 1939 premium fuels is 80; a year ago it was 79; the regular grade last year was 73, and this year it is 74. The most striking change is in third-grade gasoline, which in one year has jumped from 52 to 62 in octane number, with some having a 69 rating.

In 1932, the octane numbers of regular, premium and third-grade gasolines averaged respectively 61, 74, and 51. Comparison with the figures given in the preceding paragraph will give an idea of the progress that has been made in the last eight years. As to volatility, the third-grade gasoline has moved upward toward that of the regular grade, while the regular and premium grades show little change in volatility.

BOOKS

World Petroleum Register—Published by RUSSELL PALMER, 95 River St., Hoboken, N. J., U. S. A., and 3 Savoy Place, London, W. C. 2, England; 20th edition, 976 pages, 8½ in. by 11½ in. $10.

This large annual directory of the companies and individuals engaged in the oil industry of the world appears as the successor of two previous annuals—World Petroleum Directory and The Petroleum Register.

The contents of the new volume include pertinent information on the history, capital and corporate structure, affiliates and subsidiaries, directorates and personnel, concessions and properties, manufacturing facilities and other particulars regarding all known companies that produce oil, refine or process petroleum, manufacture liquified gas and grease, produce asphalt, carbon black and the like. Similar information is given regarding companies engaged in transportation, wholesale distribution, export and in many allied and similar fields that compose the complex business of producing and marketing the world's petroleum. There is a register of oil tankships; a list of bunkering stations of the world; lists of drilling contractors, royalty companies, trade associations, and of professional and scientific experts; an extensive buyers guide and a variety of information which it is always useful to have at hand.

The format of the book is excellent and the system of indexing is well conceived to facilitate easy reference. The register is over 200 pages larger than any previous petroleum directory and actually contains over 40 percent more listings and information.

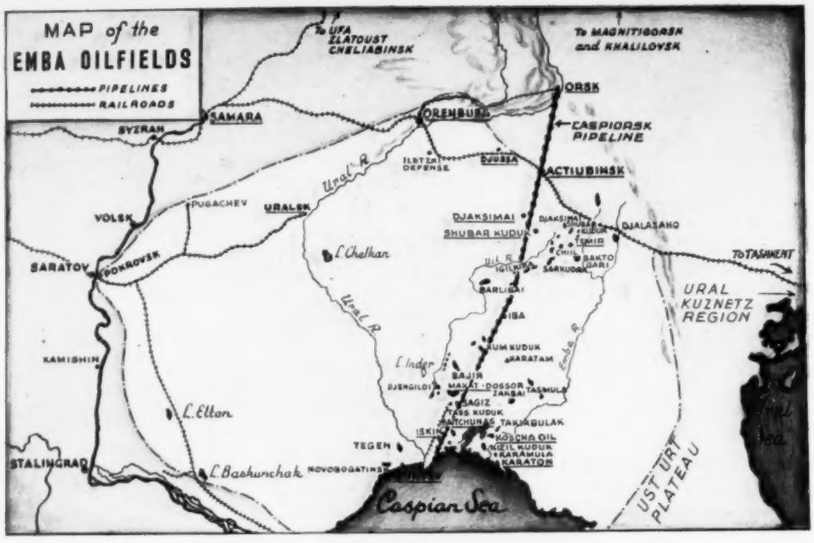
Texas Oil and Gas Since 1543—by C. A. Warner, Published 1939 by GULF PUBLISHING CO., Houston; 487 pages; $5.00. Reviewed by Michel T. Halbouty.

One of the most thorough histories of any state's major industry is to be found in C. A. Warner's "Texas Oil and Gas Since 1543." The book is an outstanding contribution to the entire oil industry, although the historical value only pertains to the State of Texas. Many men who have been connected with the oil industry of the nation have been listed in this book as having played an important part in the early days of Texas oil production. Historical documents and statistical data are presented in a most concise manner and these data alone should prove to be invaluable to oil men in the future. Between the lines of this book one cannot but see the innumerable interviews, letters and time the author spent in collecting his data. The book should prove useful as a direct reference to the source of information on early development of the oil fields in Texas, as the author delves into the minutest detail on the most significant factor that led to each discovery. The book contains the answers to hundreds of historical questions that are often asked by those interested in the oil industry, and these questions are answered in a language that is quickly understood by the oil man and decidedly fascinating to a layman.

The author begins his book by story-telling the general history of the State's oil developments, and this first chapter is as fascinating to read as the most thrilling story of an exploring expedition. The oil industry in Texas is just so—— a fascinating tale of the hopes and despairs of thousands of men who explored, found, and the continued to seek the liquid which has been symbolized as "Black Gold." The economic importance and growth of the industry is given a thorough coverage. The economic value of each phase of the industry is outlined, together with the role each played in the building of the present oil status of the State. The geological aspects governing the State's production are reviewed for each producing district. The importance of this chapter is best reflected in the author's own words as he states that "the stratigraphy and structure of Texas are subjects of major importance to the oil and gas industry and to all who secure financial returns from it. They are the factors that effectively control the accumulation of oil and gas." This particular chapter is of extreme importance to geologists, petroleum engineers and financiers who operate or intend to operate in the State of Texas.

The six producing districts of Texas, namely, East Texas, Gulf Coast, North Texas, the Panhandle, South Texas and West Texas, are well reviewed in such a manner as to designate the importance of each. The tremendous upheaval that East Texas created on the State's oil economic structure and the gradual birth of proration are well explained in this group of chapters.

The selected bibliography is important to scientists and historians, and the author has devised an effective index. The index is based on separate subject groups which immediately catch the eye of the index hunter and save considerable time. For instance, if information concerning the first oil well in Texas is desired, a complete index on all "firsts" in Texas is listed, such as the first oil well, first gas well, first pipe line. and the like. This book will be an invaluable addition to the library of every oil man, oil or gas company, and also to those who are historically inclined, because the book is full of rich, human, interesting features of the oil and gas industry of Texas.



Russian Oil Survey—
Part IV

Fifth of a Series Dealing with the Soviet Petroleum Industry in All Its Phases. Baku, Grozni, Maikop, Daghestan, Crimea, Kuban and Georgia Have Been Dealt with in Previous Issues, While This Article Surveys the Emba Oilfields. Next Month Mr. Wegrin Discusses the Ural-Volga Region and Soviet Ukraine.

NEW LABORATORY EQUIPMENT DUPLICATING PRODUCTION CONDITIONS IN THE HOLE, GIVES
Visual Proof
OF THE SUCCESS OF STRAIGHT AQUAGEL-WATER MUD FOR DRILLING-IN, IN LOW-PRESSURE AREAS
Illustration at left shows thin mud cake deposited by straight AQUAGEL-water mud as bit drills into oil sands. Illustration at right shows thick mud cake deposited by an average native mud.
Liner shown set in place and pressure from oil in formation starting to push mud cake off walls of hole. Thin AQUAGEL cake (left) comes away readily with even very low pressure. • Native clay cake (right) is only partially removed even with higher pressure.
Condition depicted as production continues. In a very short time, oil from the formation dehydrates the AQUAGEL cake (left), causing it to shrink and curl and be quickly carried away through the slots in the liner. Oil removes only a small part of the water and does not disintegrate the native clay cake, which therefore impedes the passage of the oil. Liner openings often become plugged so that only a fraction of the oil bearing horizon is open to production. Oil actually hardens many native clay cakes.
In this series of tests, filter cakes from AQUAGEL-water muds and from native clay muds, were deposited on similar cores at a pressure of 500 pounds per square inch. The AQUAGEL mud deposited a cake with a thickness of 2/16", the native clay a cake of 7/16". Heads containing either slots or perforations similar to those contained in liners were placed over the mud cakes, and back pressure, using kerosene as a medium, was applied through the cores.
Before the back pressure reached 50 pounds, the AQUAGEL-water cakes began to dehydrate, broke away from the cores, and started to pass through the liner openings. The native clay cakes remained in place behind the slotted or screened openings even though the pressure was increased to 200 pounds per square inch.
Tests of the cores used in the foregoing experiments disclosed that their permeability was greatly reduced in cases in which native muds had been used compared to those in which AQUAGEL had been used.
BAROID PRODUCTS
BAROID and COLOX-Extra Heavy Drilling Muds. • AQUAGEL and JELOX-Trouble-Proof Colloidal Drilling Muds. • STABILITE-An Improved Chemical Mud Thinner. • BAROCO-An Economical, Salt Water-Resisting Drilling Clay. • FIBROTEX-For Preventing or Regaining Lost Circulation. • AQUAGEL for CEMENT-For setting casing and restoring lost circulation. • SMENTOX-For Reconditioning Cement-Cut Muds. • ZEOGEL-Special Clay To Be Used As A Suspending Agent When Salt or Salt Water Are Encountered. • TESTING EQUIPMENT-For drilling mud analysis and control.
BAROID SALES DEPARTMENT
NATIONAL PIGMENTS & CHEMICAL DIVISION OF
NATIONAL LEAD COMPANY
BAROID SALES OFFICES • LOS ANGELES • TULSA • HOUSTON

IMPORTANCE of the Emba oilfield lies in the extent of its reserves rather than its current production, for, while the value of this field has long been recognized, its development has been slower than that of the other areas previously described. This tardy development may be attributed to the geographical isolation of the area, the adverse climatic conditions, and the press of more important problems confronting the Soviet Union.

The possible petroliferous area covers 230,000 sq. mi. and contains an estimated number of salt domes amounting to 1,200. Of these domes, only about 300 are known, and only 22 have been studied and are in operation under Glavneftdobitcha Centra I Vostoka, which directs production in the central and eastern region of Soviet Russia.

Bounded on the north by the Actiubinsk region, on the east by the Ust Urt plateau, on the south by the Caspian Sea, and on the west by the Ural river, the Emba district can be reached only by the Caspian Sea route. This route is open only during the short summer season.

Proximity of Emba to the metallurgical centers of Khalilovsk and Magnitigorsk, to Cheliabinsk—grain center and site of the new tractor plant—and to the Ural Kuznetz regions, where rapid advances have been made in development of coal, minerals, non-ferrous metals and timber, has revived interest in the projected tapping of these resources.

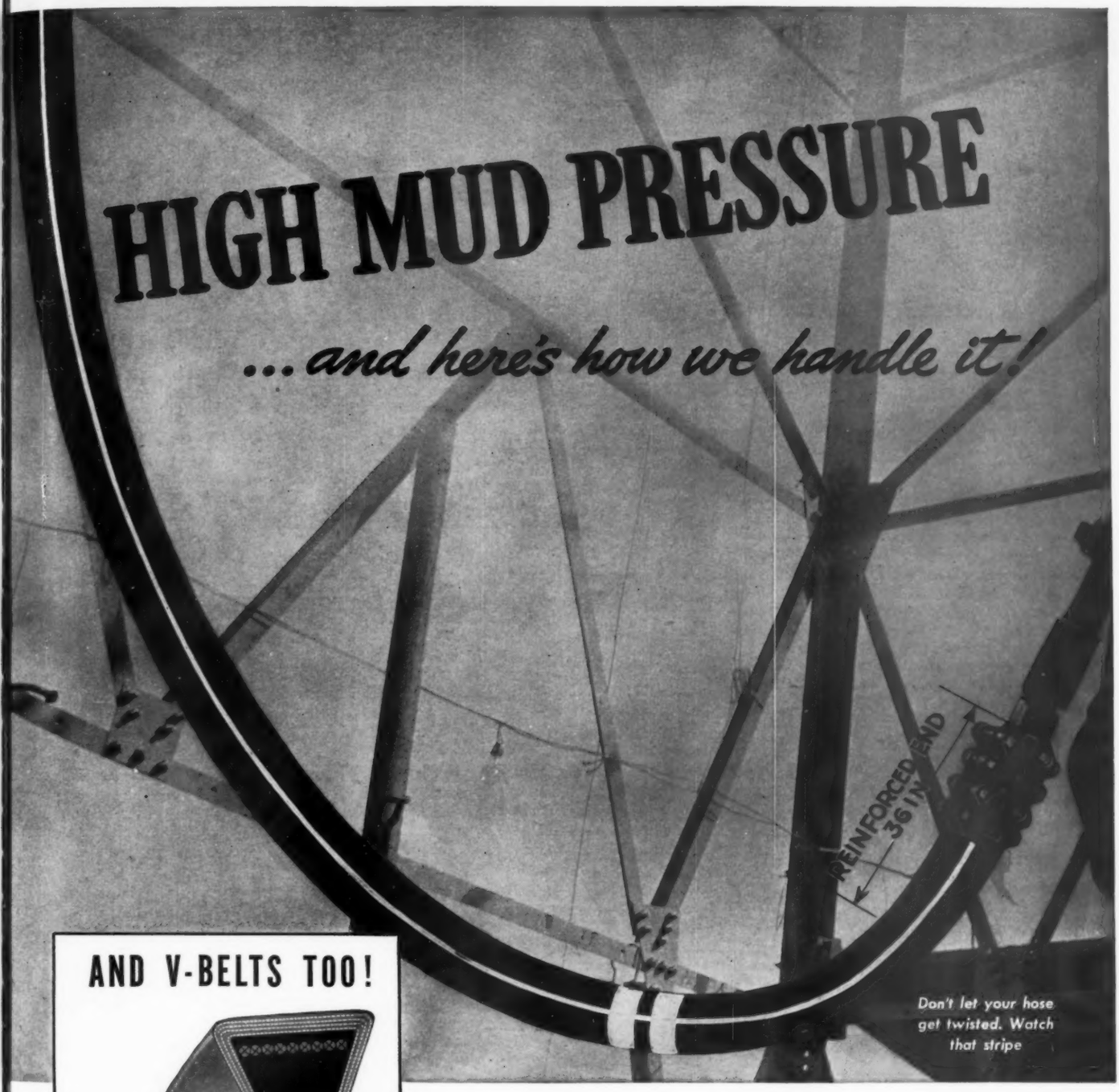
History—

The original Emba fields at Makat-Dossor are situated near Guryev, between the Ural and Emba rivers. They have been producers since 1857 but their development was slight until recent years. In 1892, some prospecting was carried on at Makat-Dossor, at Iskin, and at the Karaton properties along both banks of the Emba river, where wells drilled to depths between 85 and 140 ft. yielded 25 tons of crude per day.

During 1911, the Ural Caspian Company drilled several wells at Makat-Dossor, and at 700 ft., average production amounted to eight tons per day. Drilling continued to 1,150 ft. but no deeper horizons were found. During 1911, the first wells produced 18,000 tons and by 1915 the number of wells had increased

HIGH MUD PRESSURE

...and here's how we handle it!



Don't let your hose get twisted. Watch that stripe

AND V-BELTS TOO!

● The U. S. Rubber line of specialties for Oil Well Rotary Drilling is made complete with U. S. Rainbow V-Belts. Smooth running, uniform stretch, maximum traction is built into these longer wearing belts. Use the complete U.S. Rubber line throughout for better operating and longer wearing equipment.

ENGINEERED and built to be the strongest, most flexible, best balanced hose made . . . *reinforced with special metallic mesh tape* . . . U. S. Rubber Rotary Hose finds no drilling too deep, no pressures too great. Hour after hour, *all over the world,* this hose smoothly handles the gaff of shock pressures, bruising vibrations, and constant flexings . . . That is why . . . as new depths are reached and new heights of pressure encountered . . . oil field operators everywhere are specifying U. S. MATCHLESS (super-high pressure) and U. S. PEERLESS (high pressure) for uninterrupted rotary drilling . . . for SERVICE BEYOND PRICE and SPECIFICATIONS.

UNITED STATES RUBBER COMPANY · US · TRADE MARK

United States Rubber Export Co., Ltd.

1790 Broadway, New York, N. Y.
Branches and Representatives All Over the World

NUMBER EIGHT OF A SERIES SHOWING HOW SECURALOY INCREASES DEVELOPMENT EFFICIENCIES

FACTS YOU SHOULD KNOW ABOUT ISOLATED MULTIPLE PRODUCTION

In fields where there are two or more oil sands, each with a different formation pressure, the problem of producing each sand **economically** and **completely** is a difficult one.

In many fields, mining bureau regulations have made it necessary in the past to drill a separate well for each zone. But, by using SECURALOY Drillable Pipe and Accessories, operators are now able to drill **one** well that meets regulations and through it produce all of the oil from each of several zones . . . either from each zone in succession . . . or from all zones, simultaneously, ***through separate flow lines!***

There are at least four different multiple production methods in common use, each with its own particular advantages, and the setting and cementing procedures for these methods are outlined below. The type and placement of packers for producing these zones through separate flow lines depends on the formations, but full details will be gladly supplied by our Engineering Department on request.

METHOD NO. 1

Hole is carried through top zone and pre-perforated SECURALOY Liner is set through this zone. Then space above this zone is cemented and bottom of liner can also be cemented in place, if desired. When cement has set, reduced hole is drilled through bottom zone, a smaller SECURALOY Liner set, and space between zones filled with cement to separate each zone for isolated production.

Operators preferring this method feel that it gives them a better cement job. However, it is not as fast as Method No. 2 and necessitates a smaller liner through the second producing sand.

METHOD NO. 2

Hole is drilled through both zones and SECURALOY Liner, with pre-perforated sections opposite both upper and lower sands, is set through both zones. Using tail pipe and swab cups, space between upper and lower zones is filled with cement first and then space above top zone is cemented off, thus isolating each zone.

This method is the fastest of the four, necessitating only one trip to set liner and do both cement jobs. It also permits same size screen through both producing zones. However, some operators do not favor this method of cementing.

METHOD NO. 3

Hole is drilled through both zones and a pre-perforated SECURALOY Liner, with Security Mating Sleeve at upper end, is set through bottom zone. Space between bottom and top of liner section is filled with cement and a second pre-perforated SECURALOY Liner is run in opposite upper zone and "mated" with the previously set section. (Sleeves automatically form a fluid-tight seal between sections.) A clean-out tool then opens both sections into one solid liner.

Although this method is somewhat slower, many operators believe it is the best because it combines the cementing efficiency of Method No. 1 with the full-hole liner advantages of No. 2.

METHOD NO. 4

Hole is drilled through both zones and a blank SECURALOY Liner is cemented in place all the way up to the casing string. Then upper and lower zones are gun perforated through the pipe and cement sheath, thus opening the sands for production.

This method is relatively fast and certain because all zones are cemented off with one *continuous* cement body. But it has the disadvantage that the size of the perforations cannot be regulated to screen out fine sand particles as is possible with the other three methods where pre-perforated liner screens are used.

SECURITY ENGINEERING CO., INC.
WHITTIER, CALIFORNIA, PHONE 42064
MID-CONTINENT: 5325 CLINTON DRIVE, HOUSTON, TEXAS, PHONE CAPITOL 3038
NEW IBERIA, LOUISIANA, BOX 1111, PHONE 1359
EXPORT: SECURITY ENGINEERING CO. INC., 420 LEXINGTON AVE., NEW YORK CITY
Sievers Reamers ★ Excursion ★ Securalo Drillable Products

to 64, and the total production for the year rose to 271,000 tons.

The Soviets initiated operation of the Emba oilfields in 1924, after the nationalization of the oil industry. They started with the partially developed fields of Makat-Dossor and gradually began to exploit the properties of Baitchunas, Iskin and Koschagil, all near Guryev in the region of the Caspian Sea. In later years, prospecting and drilling operations were carried on at Djaksimai and Shubar Kuduk in the region of Temir, and at Djussa and Aktiubinsk. After the completion of the pipeline between Guryev and Orsk, Djussa and Aktiubinsk were segregated from Emba and formed into an independent oil organization called Vostokneft. Vostokneft was formed in 1937 to constitute the oil base in eastern Russia to be developed as a second Baku.

Geology—

Exploration, prospecting and operation of the Emba fields show that the oil deposits are found in conjunction with salt domes. Prospecting methods practiced in the Emba field include graviometry to establish new oil domes, geological drilling to make sub-surface studies, and seismic surveys to establish the extent of the deposits. Ten expeditions carried out this research at Emba from 1933 to 1937.

Studies made by I. G. Permiakov, noted Soviet geologist, indicate that the salt domes at Emba were formed by tangent forces on the salt beds and the Permian and Jurassic layers which were formed on top of these salt beds. This tangent force arose from the growth of new folds as the sediments of the Permian system were formed and were overthrust by Permiatrasse and Mesezoic formations. The salt beds could not withstand this great force and gave way. Hot formations, coming up from beneath the salt beds, softened the salt itself and its layers fell in softened bends. As soon as the pressure from below ceased, the Mesozoic and Permiatrasse formations embedded in the salt increased.

These softened bends are encountered frequently at Emba in the form of ravines where the salt, under pressure of the overthrust layers, has cropped up to the surface on the circumference of the ravines. The sinking formations, squeezed from above, lost their porosity and the ejected water and oil came up in the same direction as the salt to the top of the dome.

At these places where the formations covering the salt beds are large, the domes penetrate the overthrust layers. Such a condition is more favorable for the formation of oil, but the size of the salt dome does not have a direct bearing upon the formation of oil, as it may be formed in the salt beds as well. The state of maturity of the dome, however, designates the direction and method of operation that must be employed.

The largest domes found in Emba approach in size similar formations in Louisiana and Texas. These deep domes are indicated by the presence, in some parts of Emba, of increased Mesozoic formations at much lower

RENOLD
MARK 3

OIL WELL CHAIN
Designed and made to A. P. I. specification by the world's leading driving chain makers.
Send for leaflet No. 216/32
THE RENOLD & COVENTRY CHAIN CO., Ltd.
MANCHESTER, ENGLAND
Agents throughout the world

CLAYTON TANKS
FOR OIL STORAGE
IMPORTANT CONTRACTS CARRIED OUT IN-
GT. BRITAIN. FALKLAND IS.
GIBRALTAR. BERMUDAS
CEYLON
CLAYTON, SON & Co. LTD
HUNSLET LEEDS, ENGLAND
LONDON OFFICE: 2 VICTORIA ST. S.W.1

Those who make an art of living depend on this world famed hotel as the very embodiment of gracious service, true refinement and dignified hospitality.
Under the same Management as
The Gotham NEW YORK CITY
The Drake CHICAGO
The Evanshire EVANSTON, ILL.
The Town House LOS ANGELES
Belleview Biltmore BELLEAIR, FLA.
A. S. Kirkeby Managing Director

The Blackstone
Michigan Avenue · CHICAGO

NEVER before so much oil company information between two covers.

STILL $10.00 PER COPY

Announcing

TWO GREAT BOOKS IN ONE

The old-established annual of record and reference.

PETROLEUM REGISTER

has been acquired by the publisher of the World Petroleum Directory and has been consolidated with the Directory. Commencing with the 1939 edition of the combined publications the name will be

WORLD PETROLEUM REGISTER

Now in its twentieth edition, Petroleum Register has enjoyed wide distribution since it first was published in 1917. The World Petroleum Directory made its bow in 1932 and rapidly attained leadership. Its rise to the position of being the accepted work of domestic and international oil company information was a noteworthy feat of petroleum journalism. The current consolidation of the two books under one cover greatly enhances the value to the oil industry in every respect and reduces costs to both users and advertisers. With this issue is included the most comprehensive equipment Buyers Guide Catalog ever compiled.

World Petroleum Register for 1939 is now ready for distribution, and the price of the combined books will be but $10—not $20. Hence, purchasers and advertisers will receive dual value. Order your copy now! Mailing will be in order received.

WORLD PETROLEUM • 56 WEST 45th STREET • NEW YORK, N. Y.

The Accepted Standards of Pennsylvania Bright Stock Excellence Since 1900

ASTM POUR POINT	10	15	20	25
ASTM CONRADSON CARBON	.8	1.0	1.2	1.5
ASTM COLOR	3½	4	5	6

Manufactured Solely by

THE CONEWANGO REFINING CO.

Warren, Pennsylvania, U.S.A.

LEACH EXCHANGERS
for
High Temperatures
High Pressures

Fracto Control

High Heat Transfer
Low Vapor Pressure Drop
Long Tube Life
Easy Cleanability

Leach Exchangers are fully protected by U. S. and foreign patents

C. H. LEACH CO.
117 Liberty St. New York

STORAGE TANKS
any capacity
for OIL, PETROL, ETC.
ARC WELDED

We are experts in the designing, manufacture and erection of Welded Tanks.

COMPLETE INSTALLATIONS

Send us your Enquiries

OXLEY ENGINEERING CO. LTD.
HUNSLET LEEDS, 10 ENGLAND
Telephone LEEDS 27468/9 Telegrams: OXBROS LEEDS

LONDON OFFICE: Winchester House, Old Broad Street, E.C.2
Telephone: LONDON WALL 3731

strata of salt layers. The deeper domes that have been studied to-date are located at Karaton. Their formation resembles that of the Conroe field in the United States. Drilling at these domes to depths of 3,300 to 6,600 ft., made in 1937, have tapped Jurassic and Permian layers respectively. Wells drilled here have given a moderate yield, but the area is so vast that production may be increased greatly.

Small dome formations at Emba contain oil at depths between 650 and 2,000 ft. The areas of these small domes average between 125 and 250 acres. The practice of seismography has lessened the prospecting difficulties and made the location of these domes a relatively simple matter. About one-fifth of the wells opened to these domes recently each yielded between 50 and 100 tons per day, while others have averaged between five and ten tons of crude per day.

The overthrust structures in Emba are similar to corresponding formations in the Gulf and West Texas fields in the United States. The graviometric chart of the Emba region leads to a conclusion that underneath the cover of the chemical sediments there is a washed relief built up by formations of the Carboniferous and Devonian ages. At places where the salt wedges into the base of the Permian layers and comes up to the surface, there is a similarity to the Seminole, Panhandle and Oklahoma City fields. These findings are subject to revision, for the Soviets have been making seismic and graviometric studies only during the past few years.

It was believed that the Emba oil formations come from the Jurassic layers, but recent geological studies have shown that the secondary Jurassic layers also contain oil. It is still a disputed point whether the Permian overthrusts of the salt beds or the layers below the salt beds are the more favorable for commercial oil accumulation.

Permiakov believes that the oil was formed in transgressions much deeper than Jurassic; but as oil has been found in the Jurassic layers and in the Apt, Neokomsk and Permiatrasse layers, and no bitumens have been found outside this transgression, it is reasonable to suppose that most of the oil lies in the depressed salt beds. At several places in Emba, it was found that the accumulated salt deposits have filled up the syncline bends between ancient folds and that the anticline folds below the salt beds have come up and penetrated the salt as well as the Permian, Jurassic and gypsum layers. Graviometric studies have established such places along the Emba river and it is likely that this area will prove most favorable for the production of oil.

Drilling and Production—

Drilling at Emba differs from that at other Soviet fields only in the fact that the wells are deeper. Several score of deep wells, whose depths vary from 8,200 to 9,900 ft., have been sunk in the Emba fields. A typical rig in the Emba area includes a four-speed, friction reverse, Emsco-type rotary table, a 6-in. by 6,000-in. transmission, two 6¾-in.

HUGE UNIT CAPACITY

An organization devoting its efforts exclusively to the development and application of the highest Centrifugal Force commercially available to improve existing products and processes and make potential processes economically practical.

The Sharples D-4 Centrifugal was designed particularly and exclusively to meet the refiners' demand for big units.

It is much the largest centrifugal designed for petroleum refining.

Its great capacity substantially reduces capital and operating costs.

It is not intended for the solution of all refinery centrifugal problems, but for acid treatment of petroleum distillates, it is the answer.

THE SHARPLES CORPORATION

★ *CENTRIFUGAL AND PROCESS ENGINEERS* ★

2323 WESTMORELAND STREET • PHILADELPHIA • PA.

LONDON • PARIS • TOKIO

NEW YORK BOSTON PITTSBURGH CLEVELAND DETROIT CHICAGO DALLAS SEATTLE SAN FRANCISCO LOS ANGELES REPRESENTATIVES THROUGHOUT THE WORLD

by 14-in. mud pumps, two internal combustion engines (a 200-hp. motor to operate the hoist and a 120-hp. one to turn the pumps), a metal or wood derrick about 110 ft. in height, a five roller crownblock, a four-inch swivel, and two mud solution mixers driven by separate electric motors. Drilling bits used are of the disc type, 23½ in. for the first 100 ft. of the well, 19¾ in. up to a depth of 1,400 ft., 15¾ in. up to 2,000 ft., 11¾ in. up to 2,075 ft., all with six-inch drill pipe. From 2,075 ft. to 5,750 ft., a 9¾-in. bit and four-inch pipe are used, while for depths up to 8,200 ft., three-inch pipe and a 7¾ in. bit are used.

Transportation—

The Emba area is entirely dependent upon Caspian Sea transportation for its supplies and equipment as well as for the shipment of its products. The development of such fields as Shubar Kudak and Djaksimai was made possible by the construction of a pipeline from Guryev to Orsk. A railroad running from Samara to Tashkent, via Orenburg, cuts through this area and provides a means of access to these fields. There are, in addition, some pipelines connecting the Koschagil and Makat-Dossor fields to Guryev. None of these lines is used to an extent approaching its capacity. The prospects for improved transportation facilities are brighter, for work has been commenced on a railroad line that will connect Guryev with Kandagash.

Future—

Between 1911 and 1929, Emba produced a total of 1,335,000 tons of crude and in the best year of production during this period, the amount was only 273,000 tons. Despite the large number of salt domes and the formidable area available for exploitation, annual production varies between the relatively small figures of 380,000 and 460,000 tons.

During the first Five-Year Plan, Emba produced 1,535,000 tons of crude and only a slight increase was experienced during the Second Piatiletka, the amount rising to 1,800,000. Plans of the Soviet Government call for an immediate increase in output from this area, however, and the manner in which these plans are being carried out is manifested by a rise in production from 360,000 tons in 1937 to almost 500,000 tons in 1938, by the increase in prospecting that is being made in this area, and by the construction of a new pipeline from Koschagil to Orsk.

Several years ago, the deposits of Emba were estimated at 40,000,000 tons of crude, but this figure appears to be far below the actual status of the reserves in this area. The number of new fields under study since that date has increased by 20 or more and, of these, eight fields have been established definitely as commercial producers. While no accurate estimate has yet been made to revise the above figure of 40,000,000 tons, the Soviets consider that the probable reserves of this area are far in excess of that amount, and their renewed interest augurs a large rise in production from this area.

J. WEGRIN

Photographed by Hal Jones

COMPLETE SOILANE SAMPLING CREW

Operating Cost — $750.00 per Month

The Soil Samples collected by this crew can be analysed for about $3,000.00 per month.

The illustration above is the frontispiece of

"The Handbook of Geochemical Prospecting"

By E. E. Rosaire

which is now in preparation. Have you written for your copy?

Subterrex

By ELTRAN & SOILANE

ESPERSON BLDG. - HOUSTON, TEXAS

CUT DRILLING COSTS *by keeping your holes straight with* SYFO CLINOGRAPH

Write for Literature

SPERRY-SUN WELL SURVEYING COMPANY

1608 WALNUT STREET
PHILADELPHIA, PENNA.

SULPHURIC ACID

Recovery, Production, Concentration

New construction and remodeling to meet refinery needs

Chemico Sludge Conversion Plants for recovery of strong clean acid direct from raw untreated sludge
Chemico Acid Production Plants
Acid Separators and Concentrators

Consultation, design and erection with performance guaranteed

Chemical Construction Corporation

30 Rockefeller Plaza, New York, N. Y.

Cables:—Chemiconst, New York

European Representatives:

CYANAMID PRODUCTS, LTD.

14 Finsbury Circus, E. C. 2, London, England

CHEMICO PLANTS *are* PROFITABLE INVESTMENTS